EPARTMENT OF COMMERCE/Environmental Science Services Administration

WEATHER BUREAU OBSERVING HANDBOOK NO. 1

Marine Surface Observations

U.S. DEPARTMENT OF COMMERCE
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Marine Surface Observations

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DATA ACQUISITION DIVISION
OFFICE OF METEOROLOGICAL OPERATIONS
SILVER SPRING, MD.

Weather Bureau Observing Handbook No. 1, Marine Surface Observations, supersedes the Manual of Marine Meteorological Observations, Circular M, Twelfth Edition, March 1964.

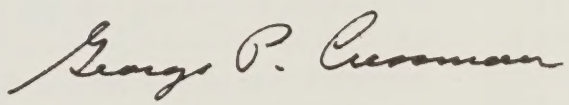
FOREWORD

Weather Bureau Observing Handbook No. 1, Marine Surface Observations, has been written to assist the officers aboard merchant vessels who voluntarily take weather observations on the high seas.

Although code tables on the Ship Code Card and the cover of the observation logbook may be used for quick reference when recording observations, they cannot serve as complete instructions for taking and recording weather observations. Therefore, a periodic study of this handbook is recommended in order that uniform weather reporting practices may be maintained.

Port Meteorological Officers are stationed in the major U.S. ports to assist you in carrying out the weather observing program. If you have questions or suggestions, contact one of the offices listed in appendix II.

The tradition of weather observing aboard merchant vessels dates back to ancient times. The Weather Bureau is grateful to the masters and officers who are contributing to the marine meteorological services through this tradition.



George P. Cressman
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Regulation 1

Application

This Chapter, unless otherwise expressly provided in this Chapter, applies to all ships on all voyages, except ships of war and ships solely navigating the Great Lakes of North America and their connecting and tributary waters as far east as the lower exit of the St. Lambert Lock at Montreal in the Province of Quebec, Canada.

Regulation 2

Danger Messages

(a) The master of every ship which meets with dangerous ice, a dangerous derelict, or any other direct danger to navigation, or a tropical storm, or encounters sub-freezing air temperatures associated with gale force winds causing severe ice accretion on superstructures, or winds of force 10 or above on the Beaufort scale for which no storm warning has been received, is bound to communicate the information by all the means at his disposal to ships in the vicinity, and also the the competent authorities at the first point on the coast with which he can communicate. This form in which the information is sent is not obligatory. It may be transmitted either in plain language (preferably English) or by means of the International Code of Signals. It should be broadcast to all ships in the vicinity and sent to the first point on the coast to which communication can be made, with a request that it be transmitted to the appropriate authorities.

(b) Each Contracting Government will take all steps necessary to ensure that when intelligence of any of the dangers specified in paragraph (a) is received, it will be promptly brought to the knowledge of those concerned and communicated to other interested Governments.

(c) The transmission of messages respecting the dangers specified is free of cost to the ships concerned.

(d) All radio messages issued under paragraph (a) of this Regulation shall be preceded by the Safety Signal, using the procedure as prescribed by the Radio Regulations as defined in Regulation 2 of Chapter IV.

Regulation 3

Information required in Danger Messages

The following information is required in danger messages:

(a) Ice, Derelicts and other Direct Dangers to Navigation.

(i) The kind of ice, derelict or danger observed;
(ii) the position of the ice, derelict or danger when last observed;
(iii) the time and date (Greenwich Mean Time) when danger is observed.

(b) Tropical Storms (Hurricanes in the West Indies, Typhoons in the China Sea, Cyclones in the Indian waters, and storms of a similar nature in other regions).

(i) A statement that a tropical storm has been encountered. This obligation should be interpreted in a broad spirit, and information transmitted whenever the master has good reason to believe that a tropical storm is developing or exists in his neighborhood.
(ii) Time, date (Greenwich Mean Time) and position of ship when the observation was taken.
(iii) As much of the following information as is practicable should be included in the message:

- barometric pressure, preferably corrected (stating millibars, inches, or millimeters, and whether corrected or uncorrected);
- barometric tendency (the change in barometric pressure during the past three hours);
- true wind direction;
- wind force (Beaufort scale);

- state of the sea (smooth, moderate, rough, high);
- swell (slight, moderate, heavy) and the true direction from which it comes. Period or length of swell (short, average, long) would also be of value;
- true course and speed of ship.

(c) Subsequent Observations. When a master has reported a tropical or other dangerous storm, it is desirable, but not obligatory, that further observations be made and transmitted hourly, if practicable, but in any case at intervals of not more than three hours, so long as the ship remains under the influence of the storm.

(d) Winds of force 10 or above on the Beaufort scale for which no storm warning has been received.

This is intended to deal with storms other than the tropical storms referred to in paragraph (b); when such a storm is encountered, the message should contain similar information to that listed under paragraph (b) but excluding the details concerning sea and swell.

(e) Sub-freezing air temperatures associated with gale force winds causing severe ice accretion on superstructures.

(i) Time and Date (Greenwich Mean Time).
(ii) Air temperature.
(iii) Sea temperature (if practicable).
(iv) Wind force and direction.

EXAMPLES

Ice
TTT Ice. Large berg sighted in 4605 N., 4410 W., at 0800 GMT. May 15.

Derelicts
TTT Derelict. Observed derelict almost submerged in 4006 N., 1243 W., at 1630 GMT. April 21.

Danger to Navigation
TTT Navigation. Alpha lightship not on station. 1800 GMT. January 3.

Tropical Storm
TTT Storm. 0030 GMT. August 18. 2204 N., 1154 E. Barometer corrected 994 millibars, tendency down 6 millibars. Wind NW., force 9, heavy squalls. Heavy easterly swell. Course 067,5 knots.

TTT Storm. Appearances indicate approach of hurricane. 1300 GMT. September 14. 2200 N., 7236 W.B Barometer corrected 29,64 inches, tendency down .015 inches. Wind NE., force 8, frequent rain squalls. Course 035,9 knots.

TTT Storm. Conditions indicate intense cyclone has formed. 0200 GMT. May 4. 1620 N., 9203 E. Barometer uncorrected 753 millimeters, tendency down 5 millimeters. Wind S. by W., force 5. Course 300,8 knots.

TTT Storm. Typhoon to southeast. 0300 GMT. June 12. 1812 N., 12605 E. Barometer falling rapidly. Wind increasing from N.

TTT Storm. Wind force 11, no storm warning received. 0300 GMT. May 4. 4830 N., 30 W. Barometer corrected 983 millibars, tendency down 4 millibars. Wind SW., force 11 veering. Course 260,6 knots.

Icing
TTT experiencing severe icing. 1400 GMT. March 2. 69 N., 10 W. Air temperature 18. Sea temperature 29. Wind NE., force 8.

Regulation 4

Meteorological Services

(a) The Contracting Governments undertake to encourage the collection of meteorological data by ships at sea and to arrange for their examination, dissemination and exchange in the manner most suitable for the purpose of aiding navigation. Administrations shall encourage the use of instruments of a high degree of accuracy, and shall facilitate the checking of such instruments upon request.

(b) In particular, the Contracting Governments undertake to cooperate in carrying out, as far as practicable, the following meteorological arrangements:

(i) To warn ships of gales, storms and tropical storms, both by the issue of radio messages and by the display of appropriate signals at coastal points.
(ii) To issue daily, by radio, weather bulletins suitable for shipping, containing data of existing weather, waves and ice, forecasts and, when practicable, sufficient additional information to enable simple weather charts to be prepared at sea and also to encourage the transmission of suitable facsimile weather charts.

(iii) To prepare and issue such publications as may be necessary for the efficient conduct of meteorological work at sea and to arrange, if practicable, for the publication and making available of daily weather charts for the information of departing ships.

(iv) To arrange for selected ships to be equipped with tested instruments (such as a barometer, a barograph, a psychrometer, and suitable apparatus for measuring sea temperature) for use in this service, and to take meteorological observations at main standard times for surface synoptic observations (at least four times daily, whenever circumstances permit) and to encourage other ships to take observations in a modified form, particularly when in areas where shipping is sparse; these ships to transmit their observations by radio for the benefit of the various official meteorological services, repeating the information for the benefit of ships in the vicinity. When in the vicinity of a tropical storm, or of a suspected tropical storm, ships should be encouraged to take and transmit their observations at more frequent intervals whenever practicable, bearing in mind navigational preoccupations of ships' officers during storm conditions.

(v) To arrange for the reception and transmission by coast radio stations of weather messages from and to ships. Ships which are unable to communicate direct with shore shall be encouraged to relay their weather messages through ocean weather ships or through other ships which are in contact with shore.

(vi) To encourage all masters to inform ships in the vicinity and also shore stations whenever they experience a wind speed of 50 knots or more (force 10 on the Beaufort scale).

(vii) To endeavor to obtain a uniform procedure in regard to the international meteorological services already specified, and, as far as is practicable, to conform to the Technical Regulations and recommendations made by the World Meteorological Organization, to which the Contracting Governments may refer for study and advice any meteorological question which may arise in carrying out the present Convention.

(c) The information provided for in this Regulation shall be furnished in form for transmission and transmitted in the order of priority prescribed by the Radio Regulations, and during transmission "to all stations" of meteorological information, forecasts and warnings, all ship stations must conform to the provisions of the Radio Regulations.

(d) Forecasts, warnings, synoptic and other meteorological reports intended for ships shall be issued and disseminated by the national service in the best position to serve various zones and areas, in accordance with mutual arrangements made by the Contracting Governments concerned.

Regulation 5

Ice Patrol Service

(a) The Contracting Governments undertake to continue an ice patrol and a service for study and observation of ice conditions in the North Atlantic. During the while of the ice season the south-eastern, southern and south-western limits of the regions of icebergs in the vicinity of the Grand Banks of Newfoundland shall be guarded for the purpose of informing passing ships of the extent of this dangerous region; for the study of ice conditions in general; and for the purpose of affording assistance to ships and crews requiring aid within the limits of operation of the patrol ships. During the rest of the year the study and observation of ice conditions shall be maintained as advisable.

(b) Ships and aircraft used for the ice patrol service and the study and observation of ice conditions may be assigned other duties by the managing Government, provided that such other duties do not interfere with their primary purpose or increase the cost of this service.

CHAPTER 1

GENERAL INSTRUCTIONS

1. General.

1.1 Routine activities of a weather observing program are discussed in this chapter. Routine activities are: establishing a weather observing schedule; filling out a blank observation log sheet prior to entering observations; radio transmission details, the weather code, missing data in the code; and ordering supplies.

2. Basic Observing Schedule.

2.1 Observations should be taken at sea for the hours 0000, 0600, 1200 and 1800 Greenwich Mean Time. These times are referred to by the World Meteorological Organization (WMO) as the "standard hours of primary surface synoptic observations." In this handbook, the term "standard hour" and the foregoing WMO phrase are synonymous.

2.2 Other Schedules. Ocean station vessels, Naval vessels and some research ships are scheduled to take observations more often than every six hours. Merchant vessels will only take observations at other than standard hours when the provisions of ¶2.3, 2.4, or 2.5 apply.

2.3 Mandatory Reports. Chapter V of the International Conference for the Safety of Life at Sea states that a weather message must be prepared and transmitted when the ship encounters a tropical storm. The form and content of such messages is prescribed in the aforementioned document, which has been reproduced as appendix I of this handbook.

2.4 Requested Reports. Once a tropical cyclone has been detected, a meteorological center may broadcast requests for special observations at regular intervals (hourly, two-hourly or three-hourly) from ships in the vicinity of the storm. When issued, such requests will be included at the end of marine weather bulletins or they may be addressed specifically to the ship. While such requests are in effect, all observations, regular and special, should be sent to the address given in the request.

2.5 Single Radio Operator Ships. On single radio operator ships, it may not be possible to transmit each six-hourly observation on the standard hours owing to the difficulties resulting from fixed radio watch hours. The observer should be guided by the procedures listed below, shown in their order of priority, in order to ensure that the maximum number of observations are transmitted each day.

Figure 1-1. Ship's Weather Observations, Form 72-1.

SHIP'S NAME ☐ S/S ☑ M/V	MONTH AND YEAR	BAROMETER NUMBER	ESSA FORM 72-1 (1-68)
COMBO	JULY 19 70	WB 325	U.S. DEPARTMENT OF COMMERCE ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION WEATHER BUREAU
CALL SIGN: WOCH	VOYAGE FROM: PORT	DATE LAST CHECKED: 6/6/70	SHIP'S WEATHER OBSERVATIONS
COUNTRY OF REGISTRY: U. S. A.	VOYAGE TO: PORT	CORRECTION: -0-	

1	2	3	4	5	6	7	8	9	10	11	12	13	15	16	17	18	19	20	21	22	23
IND.	LATITUDE (Degrees and tenths, 3 figures)	QUADRANT OF GLOBE	LONGITUDE (Degrees and tenths, 4 figures)	DAY OF MONTH GMT (2 figures)	TIME GMT (2 figures)	WIND INDICATOR (Coded)	TOTAL CLOUD AMT.	WIND DIRECTION (degrees (00 = calm))	WIND SPEED (True knots)	VISIBILITY (Coded 90 - 99)	PRESENT WEATHER (Coded 00 - 99)	PAST WEATHER (0 - 9)	SEA LEVEL PRESSURE (Millibars and tenths, Last 3 figures in Col. 15 and first "9" or "10" in Col. 14)	AIR-TEMP. DATA °C DRY BULB (Degrees in Col. 16, tenths in Col. 17 & 33)	WET BULB (Degrees and tenths)	AMOUNT OF LOWEST CLOUDS	TYPE OF LOW CLOUD	HEIGHT OF LOWEST CLOUDS	TYPE OF MIDDLE CLOUD	TYPE OF HIGH CLOUD
99	$L_aL_aL_a$	Q_c	$L_oL_oL_oL_o$	YY	GG	i_w	N	dd	ff	VV	ww	W	PPP	TT	–	–	N_h	C_L	h	C_M	C_H
99	651	7	1680	28	00	4	0	33	03	98	02	0	10	108	10	.1	9.2	0	0	9	0	0
99	367	5	1872	13	06	3	7	23	25	98	18	8	10	081	10	.5	9.5	7	7	4	/	/
99	344	5	1496	16	62 ✕	3	9	05	21	93	82	6	10	119	14	.5	–					
99	095	7	1359	19	48 ✕	3	8	32	02	98	25	9	10	135	26	.2	22.5	8	5	3	0	0
99	576	3	1450	15	00	4	8	23	36	98	85	2	9	925	53	.1	-4.2	8	7	4	/	/
99					06																	
99					12																	
99					18																	
99					00																	
99					06																	
99					12																	
99					18																	
99					00																	
99					06																	
99					12																	
99					18																	
99	$L_aL_aL_a$	Q_c	$L_oL_oL_oL_o$	YY	GG	i_w	N	dd	ff	VV	ww	W	PPP	TT			N_h	C_L	h	C_M	C_H

Note:

ESSA FORM 72-1 REPLACES WB FORM 615-5 WHICH IS OBSOLETE. EXISTING STOCKS SHOULD BE DESTROYED AFTER JANUARY 1, 1968.

Form Approved; Budget Bureau No. 41-R1258

GENERAL INSTRUCTIONS
(See observing handbook for more details)

1. Fill in all blanks on upper left-hand side of this form.
2. Check appropriate box in column 32.
3. Before entering, convert:
   a. all temperatures to °C.
   b. all pressures to millibars.
   c. if conversion tables not available, enter values as observed, followed by letters or abbreviations for the first entry on each form, ("77.5°F", "29.905 in.", etc.)
4. Begin a new sheet each month, voyage, ocean and quadrant.
5. Transmit data in 5-figure groups from unshaded columns and remarks. See observing handbook, section 1-04 for handling missing data.

24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
COURSE OF SHIP (Coded 0 - 9)	SPEED OF SHIP (Coded 0 - 9)	3-HOUR PRESS. CHANGE: CHARACTER OF CHANGE	3-HOUR PRESS. CHANGE: AMOUNT OF CHANGE (Mb and tenths)	AIR-SEA TEMP. DIFFERENCE: INDICATOR	AIR-SEA TEMP. DIFFERENCE (Coded)	DEW POINT FROM TABLE 30	SEA TEMPERATURE °C (Degrees and tenths 3 figures) CHECK ONE ☐ BUCKET ☑ INTAKE	TENTHS OF AIR TEMP. INDICATOR	WAVES (Make as many groups as patterns observed) WIND WAVES: PERIOD (Avg. seconds 2 figures)	WIND WAVES: HEIGHT (Coded)	SWELL: DIRECTION (tens of degrees)	SWELL: PERIOD (Coded)	SWELL: HEIGHT (Coded)	ADDITIONAL MESSAGE GROUPS AND REMARKS (More swell groups, 2 $I_sE_sE_sR_s$, ICE C_2KD_ire, Wind Shifts, beginning and ending of precip., freak waves, etc.)	CHECK IF SENT BY RADIO: OBSERVERS INITIALS
D_s	v_s	a	pp	0	T_sT_s	T_dT_d	1	$T_wT_wT_w$	t_T	3	P_wP_w	H_wH_w	d_wd_w	P_w	H_wH_w	–	–
7	3	5	04	0	//	08	1	089	1	3	00	00					✓ AS
2	4	0	00	0	//	09	1	150	2	3	06	10	16	9	06	WIND SHIFT 0440 SE TO SW (RWB 2200 E 2230)	✓ MWM
~~X~~	~~X~~	~~X~~	~~X~~	0	//	~~X~~	1	163	5	3	06	05	29	8	06	(RE 0950 RWB 1140)	✓
													24	4	02		WDH
~~X~~	~~X~~	~~X~~	~~X~~	0	//	21	1	300	2	3	00	00				(TRW B1420 TE 1500) (RWE 1710)	✓ AGK
4/9	2/9	2/1	99/35	0	//	57	1	003	1	3	11	12				ICE 3 BERGS	✓ LEG
							1			3							
							1			3							
							1			3							
							1			3							
				0	//		1			3							
				0	//		1			3							
				0	//		1			3							
				0	//		1			3							
				0	//		1			3							
				0	//		1			3							
				0	//		1			3							
				0	//		1			3							
D_s	v_s	a	pp	0	T_sT_s	T_dT_d	1	$T_wT_wT_w$	t_T	3	P_wP_w	H_wH_w	d_wd_w	P_w	H_wH_w	–	–

Extra group "99ppp" may be entered as shown above, or in column 40.

2.5.1 If the radio watch ends one hour, or less, before a standard hour, the observation should be taken and transmitted an hour early. The element of the observation which refers to the time (GG) should be altered to show the actual hour, e.g., 05, 11, 17 or 23. Do not take the regular observation scheduled for the following (standard) hour.

2.5.2 If the radio watch ends one to three hours before a standard hour, take an observation for the intermediate hour of 0300, 0900, 1500 or 2100 GMT. Alter the time element of the observation (GG) to indicate the actual hour, e.g., 03, 09, 15 or 21. For climatological purposes, take the observation scheduled for the standard hour three hours later even though it may not be possible to transmit it.

2.5.3 When the radio watch ends earlier than the times specified in 2.5.1 or 2.5.2, take each scheduled observation on time. Observations made at any of the standard hours may be transmitted up to four hours late, if this arrangement will fit in with the radio watch hours. In the Southern Hemisphere and in any of the "sparse data areas" shown on maps supplied by the Port Meteorological Officer, observations may be transmitted up to twelve hours old.

2.6 Observations should be taken according to the foregoing schedules on all oceans and seas, even when close to a sea coast.

3. Observation Log.

3.1 ESSA Form 72-1. Shipboard weather observational data are recorded on ESSA Form 72-1 entitled "Ship's Weather Observations" see Figure 1-1. Each pad of forms is bound with a set of tables for use in preparing data for entry on the forms. The last three sheets in each pad contain cloud identification photographs together with their definitions and code figures. These three sheets may be removed and displayed more conveniently.

3.2 Preparation of the Form. Before commencing observations on a new form, all data blocks in the upper left-hand corner of the form and in Column 32 should be filled in. The data required are described below.

a. Ship's name - check appropriate box and enter name of ship.

b. Call sign - enter ship's radio call sign.

c. Country of registry - enter name of country where vessel is registered.

d. Month and year - Enter current GMT month and year.

e. Voyage from-to - enter port of departure and destination.

f. Barometer No. - enter serial number, (Weather Bureau or manufacturer's) if any.

g. Date last checked - enter date of last barometer comparison made by your Weather Bureau contact.

h. Correction - enter the correction which was determined on the above date.

i. Column 32 - check the appropriate box indicating whether water temperature is read at the sea water intake or by bucket sample over the side.

3.3 When to Change Forms. Observation forms from your ship are filed at the National Weather Records Center by month, quadrant* of the globe, ocean, and single voyage. Therefore, a new form should be started each time one of the following factors changes:

a. Month (GMT)

b. Quadrant*

c. Ocean

d. Voyage

Each form should be checked when removed from the pad to see that the data requested in ∫3.2 are completed. Used forms may be stored in the back of the pad.

3.4 Disposition of Used Forms. Each time the ship returns to a U.S. territorial port, mail all forms which contain one or more observations in the envelopes provided by the Port Meteorological Officer. Barograph records should also be included. These records are discussed in Chapter 6.

4. Radio Transmission of Weather Reports.

4.1 Weather Report Definition. When an observation is completed and the data encoded in the International Ship's Meteorological Code (FM 21.D), the observation is termed a weather report. This term will be used

*See Chapter 2, Section 3.

to refer to the encoded portion of an observation entered on ESSA Form 72-1.

4.2 ESSA Form 72-4. ESSA Form 72-4 entitled "Weather Report for Immediate Radio Transmission" is used to deliver the weather report to the radio operator (see Figure 1-2). Copy the data on ESSA Form 72-4 from the unshaded columns of ESSA Form 72-1 and any entries in column 40 which are to be transmitted.

ESSA FORM 72-4 (5-68)

U.S. DEPARTMENT OF COMMERCE
ESSA - WEATHER BUREAU

WEATHER REPORT FOR IMMEDIATE RADIO TRANSMISSION

NO.	SHIP OF ORIGIN	GROUP COUNT	FILING MO/DATE	FILING TIME	FORWARDING MO/DATE	FORWARDING TIME	RELAYED BY: (Radio Station)	OPERATOR

----------These blocks may be filled in by Radio Officer if required locally ----------

TO: OBS METEO WASHINGTON
(Specify Address)

$99L_aL_aL_a$	$Q_cL_oL_oL_oL_o$	$YYGGi_w$	$N\,ddff$	$VVwwW$
99350	70700	21063	30903	98020
PPPTT	$N_hC_LhC_MC_H$	D_sv_sspp	$0T_sT_sT_dT_d$	$1T_wT_wT_wt_wT$
09520	11602	33400	0//10	11963
* $2I_sE_sE_sR_s$	$3P_wP_wH_wH_w$	$d_wd_wP_wH_wH_w$	ADDITIONAL GROUPS OR PLAIN LANGUAGE	
———	30000			

*IF NO ICE ACCRETION OBSERVED, OMIT GROUP ENTIRELY - DO NOT ENTER SLANTS.

TO RADIO OFFICER: SEND MESSAGE WITHOUT SIGNATURE

Figure 1-2. ESSA Form 72-4

4.3 Radio Address for Weather Reports. The address should be entered by the radio officer, since the selection of the address will depend upon the radio station finally contacted. The contraction OBS should be transmitted in all addresses in order to secure the appropriate answering and forwarding priority from the shore stations. Addresses for weather report collection centers are found in the Weather Bureau booklet entitled "U.S. and Foreign Coastal Radio Stations Accepting Ships' Weather Messages".

4.3.1 When the ship is in an area where special observations have been requested, or when an observation is initiated by the ship because of suspected tropical cyclone conditions, the observer should enter the

word STORM immediately ahead of the $99L_aL_aL_a$ group, leaving space on the address line of Form 72-4 for the radio operator to enter the appropriate address. As an example, the address would be transmitted "OBS METEO WASHINGTON STORM 99etc."

4.4 Disposition of ESSA Form 72-4. When the message has been transmitted. Form 72-4 may be disposed of as the radio officer sees fit. Do not mail the form to the Weather Bureau.

5. Code For Transmission.

5.1 Unshaded Portions of ESSA Form 72-1. Entries in the columns on Form 72-1 which are not shaded form the International Ship's Meteorological Code (FM21.D) when arranged in 5-figure groups. Groups which are not on the form are the $2I_sE_sE_sR_s$ group (¶10-2) and ICE c_2KD_ire (¶10-4). These groups are entered on Form 72-1 in column 40, but placed in their proper order on Form 72-4 for transmission.

5.1.1 The ship's code is shown below in symbolic form. Parentheses around groups indicate that the group is omitted when none of the elements within the group are observed.

World Meteorological Organization Code FM21.D, surface weather report from ship in full form:

$99L_aL_aL_a\ Q_cL_oL_oL_oL_o\ YYGGi_w\ Nddff\ VVwwW\ PPPTT\ N_hC_LhC_MC_H\ D_sv_sapp\ (7RRjj\ 8N_sCh_sh_s\ 9S_pS_ps_ps_p)^*\ (0T_sT_sT_sT_s)\ (1T_wT_wT_wt_T)\ (2I_sE_sE_sR_s)\ (3P_wP_wH_wH_w\ (d_wd_wP_wH_wH_w))$ (ICE followed by plain language or by code group c_2KD_ire).

The symbols are explained in Table 1-1 together with references to aid in locating pertinent observing and encoding instructions.

5.1.2 Special groups or plain language statements are required in unusual circumstances as addendum to the code above. These groups are discussed in later chapters of this handbook, e.g. ¶6.5.4.

*Merchant vessels will not encode the groups beginning with indicator 7, 8 and 9 in parentheses above.

TABLE 1-1. - Elements of the Code

Group Number	Code Symbol	Definition	Coding Instructions (Chapter-Paragraph)	Observing Instructions (Chapter-Paragraph)	Code Table No. in Appendix III
1	99	Indicator for Ship Weather Report	-	-	-
	$L_aL_aL_a$	Latitude	-	2-2.1	-
2	Q_c	Quadrant of the Globe	-	2-2.2	1
	$L_oL_oL_oL_o$	Longitude	-	2-2.2	-
3	YY	Day of the Month	-	2-3.1	-
	GG	Hour, Greenwich Mean Time	-	2-3.2	-
	I_w	Type of Wind Speed Reported	-	2-4	2
4	N	Fraction of Celestial Dome Covered by Clouds	8-2	8-4.2	3
	dd	Direction from which the Wind is Blowing	3-2,3 and 4	3-7.2	4
	ff	Wind Speed	3-2,3 and 4	3-7.3	-
5	VV	Prevailing Visibility	4-2	4-3	5
	ww	Present Weather	5-3	5-4	6
	W	Past Weather	5-4	5-4.3	7
6	PPP	Atmospheric Pressure at Sea Level	6-2.2	6-5.1.2	8
	TT	Air Temperature	7-2.2	7-5.2	9 (°F to °C)
7	N_h	Fraction of Celestial Dome Covered by All the C_L (or C_M) Clouds Present	8-2.3	8-4.3	10
	C_L	Type of Low Cloud (Low e'tage)	8-4.5	8-4.5	11
	h	Height of Lowest Cloud Seen	8-3	8-4.4	12
	C_M	Type of Middle Cloud (Middle e'tage)	8-4.5	8-4.5	13
	C_H	Type of High Cloud (High e'tage)	8-4.5	8-4.5	14
8	D_s	Course of Ship	-	2-5.2	15
	v_s	Speed of Ship	-	2-5.3	16
	a	Character of 3-hour Pressure Change	6-4	6-5.2.2	17
	pp	Amount of 3-hour Pressure Change	6-4.2.1a 4.3	6-5.2.3	18
9	ø	Group Indicator	-	-	-
	T_sT_s	Difference between Air and Sea Temperature	-	6-5.4	-
	T_dT_d	Temperature of Dew Point	6-2.3	6-5.5	19
10	1	Group Indicator	-	-	-
	$T_wT_wT_w$	Sea Water Temperature	7-2.4	7-5.6	9 (°F to °C)
	t_T	Tenths of Air Temperature	7-2.2	7-5.2	
11	2	Group Indicator	-	-	-
	I_s	Source of Ice Accretion On Ship	10-2.2.2	10-2.2.2	20
	E_sE_s	Thickness of Ice Accretion	10-2.2.3	10-2.2.3	21
	R_s	Rate of Ice Accretion	10-2.2.4	10-2.2.4	22
12	3	Group Indicator	-	-	-
	P_wP_w	Period of Waves	9-2.2	9-3.3.1	23
	H_wH_w	Height of Waves	9-2.3	9-3.2	24
13	d_wd_w	Direction from which Swell is Coming	9-2.5	9-3.4	25
	P_w	Period of Swell	9-2.2	9-3.3.2	26
	H_wH_w	Height of Swell	9-2.3	9-3.2	24
14	ICE	Group Indicator	-	10-4.1.1	-
	c_2	Kind of Ice	10-3.4	10-4.1.2	27
	k	Effect of Ice on Navigation	-	10-4.1.3	28
	D_i	Bearing of Ice-Limit	10-3.5	10-4.1.4	29
	r	Distance of Ice from Ship	10-3.5	10-4.1.5	30
	e	Orientation of Ice-Limit	10-3.5	10-4.1.6	31

6. Missing Data.

6.1 The term "missing data" is defined as data which would normally be included in the weather report but are not available for any reason. General rules for indicating missing data are given below, and in the coding sections of chapters which deal with the specific elements of the observation.

6.2 Missing Elements Within a Group. When a code element cannot be determined, substitute a slant "/" for each missing figure in the weather report to maintain the sequence of elements within the code group.

6.3 Missing Groups.

6.3.1 When all elements of a single group are missing, use the following procedures:

a. If the group is one of the first six groups ($99L_aL_aL_a$ thru PPPTT) substitute "/////" for the missing group.

b. If the $N_hC_LhC_MC_H$ group is missing, but the $D_sv_s$app group is not, substitute "/////" for the missing group.

c. If both the $N_hC_LhC_MC_H$ and $D_sv_s$app groups are missing, and additional groups follow, add 60 to the numerical value of "GG" in the $YYGGi_w$ group and omit the missing groups in the report. For example, in the 0600 GMT observation, GG is encoded "66" (06 + 60).

d. If the $D_sv_s$app group is missing, the $N_hC_LhC_MC_H$ group is included and additional groups follow, 30 is added to the numerical value of "GG". For example, in the 1200 GMT observation, to indicate that the $D_sv_s$app group is omitted, GG becomes 42 (12 + 30).

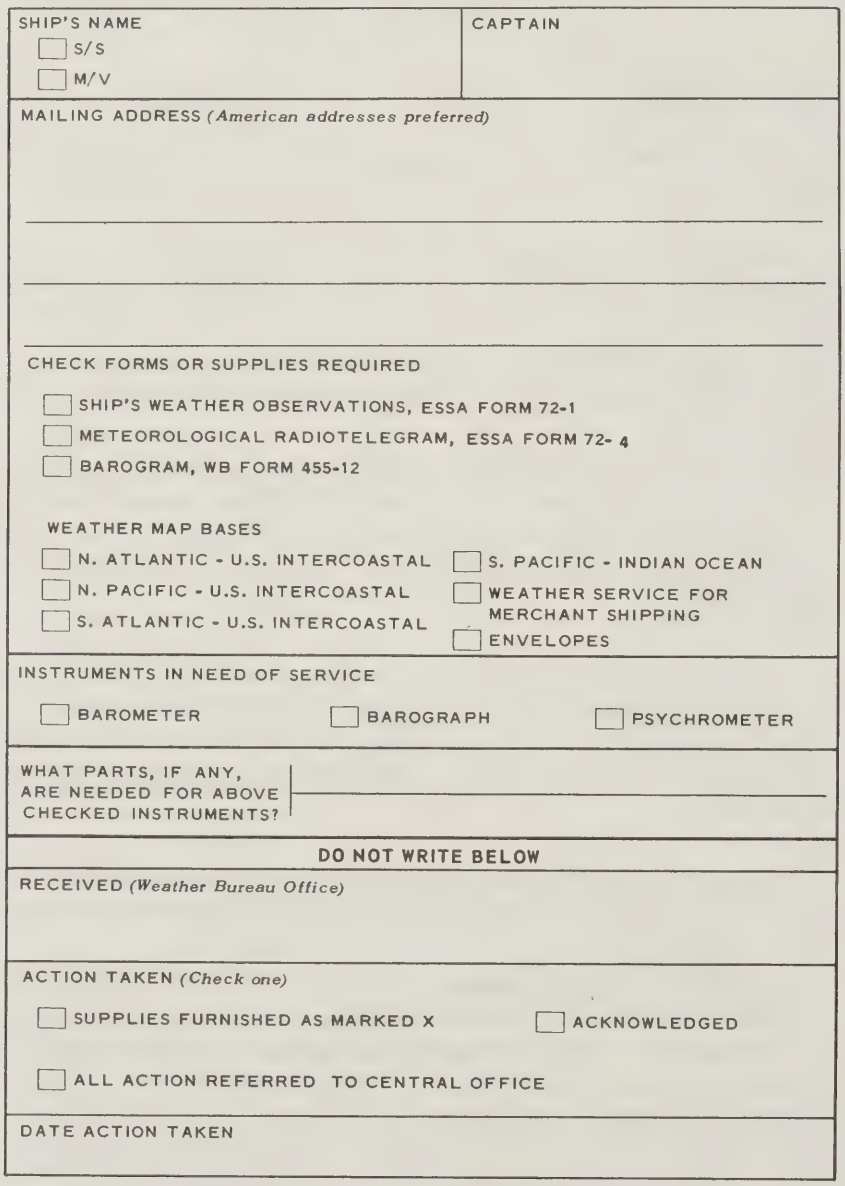
e. Groups in symbolic form in ¶5.1.2 which begin with "0", "1" or "2" may be omitted when the data are not available.

f. The group $3P_wP_wH_wH_w$ shall be omitted only when both wind waves and swell ($d_wd_wP_wH_wH_w$) are not observed. When swell is observed, the group $3P_wP_wH_wH_w$ must precede the swell group, even when wind waves are calm (30000), confused (399//) or not observed (3////).

7. Supplies and Services.

7.1 Supplies may be ordered by checking the appropriate blocks on the back of ESSA Form 72-1 (Figure 1-3), or by contacting the Port Meteorological Officer. Addresses and telephone numbers of U.S. Port Meteorological Officers are given in Appendix II.

7.2 The Port Meteorological Officer will answer questions on weather services when he visits your ship. He can provide handbooks, weather plotting charts and related publications. Upon request, the Port Meteorological Officers will arrange to conduct lectures on weather observing, weather map preparation and related marine meteorological subjects.



SHIP'S NAME
☐ S/S
☐ M/V

CAPTAIN

MAILING ADDRESS *(American addresses preferred)*

CHECK FORMS OR SUPPLIES REQUIRED

☐ SHIP'S WEATHER OBSERVATIONS, ESSA FORM 72-1
☐ METEOROLOGICAL RADIOTELEGRAM, ESSA FORM 72-4
☐ BAROGRAM, WB FORM 455-12

WEATHER MAP BASES

☐ N. ATLANTIC - U.S. INTERCOASTAL
☐ N. PACIFIC - U.S. INTERCOASTAL
☐ S. ATLANTIC - U.S. INTERCOASTAL
☐ S. PACIFIC - INDIAN OCEAN
☐ WEATHER SERVICE FOR MERCHANT SHIPPING
☐ ENVELOPES

INSTRUMENTS IN NEED OF SERVICE

☐ BAROMETER ☐ BAROGRAPH ☐ PSYCHROMETER

WHAT PARTS, IF ANY, ARE NEEDED FOR ABOVE CHECKED INSTRUMENTS?

DO NOT WRITE BELOW

RECEIVED *(Weather Bureau Office)*

ACTION TAKEN *(Check one)*

☐ SUPPLIES FURNISHED AS MARKED X ☐ ACKNOWLEDGED

☐ ALL ACTION REFERRED TO CENTRAL OFFICE

DATE ACTION TAKEN

Figure 1-3. Back of ESSA Form 72-1.

CHAPTER 2

IDENTIFICATION DATA

1. General.

1.1 There are several identification figures which must be included in a weather report to enable the user to evaluate the observation. In the ship's code, these data are latitude, quadrant of the globe, longitude, day of month, time, type of wind data, course of the ship, and speed of the ship. On ESSA Form 72-1, these data are entered in columns 2, 3, 4, 5, 7, 24 and 25.

2. Location.

2.1 Latitude ($L_aL_aL_a$). Enter the latitude in degrees and tenths at the time of the observation in column 2. Always enter three figures, without the decimal. Minutes of latitude are converted to tenths by dividing the minutes by 6 and ignoring the remainder. For example a latitude of 9°51' is converted to 9.8° and entered "098" in column 2.

2.2 Quadrant of the Globe (Q_c). Select a code figure from table 1, appendix III for the quadrant of the globe on which the ship is sailing. Enter the figure in column 3.

2.3 Longitude ($L_oL_oL_o$). Enter the longitude at the time of observation in degrees and tenths in column 4. Convert minutes of longitude to tenths by dividing the minutes by 6 and ignoring the remainder. Always enter four figures without the decimal. For example, 1°45' longitude is entered "0017", 17°18' is entered "0173", and 173.0° is entered "1730".

3. Date and Time.

3.1 Day of the Month. Enter the date, GMT, in column 5, using two figures. For example, April 1 is entered "01", April 23 is entered "23".

3.1.1 Observations completed at 2330 GMT or later, will be assigned the date of the day coming up, not the day which is ending.

3.2 Time. (GG) Time of the four standard hours are pre-printed in column 6 for your convenience. These figures represent the nearest hour, GMT, using the 24-hour clock. Use "00" rather than "24" to indicate the midnight hour. If observations are taken at times other than the standard hours, draw a line through the pre-printed hour and enter the actual hour in column 6, using two figures. When you return to reporting

at standard times, enter your observation on the next line bearing the appropriate pre-printed time. See ¶1-6.3c and d. for special coding of GG when certain groups are missing from the weather report.

4. Type of Wind Reported (I_W).

4.1 General. The I_W code is used to specify whether the wind speed (symbol ff in the fourth group of the ship's code) was estimated or measured and whether the value represents meters per second or knots. Wind speeds are reported in knots in the U.S. version of the code.

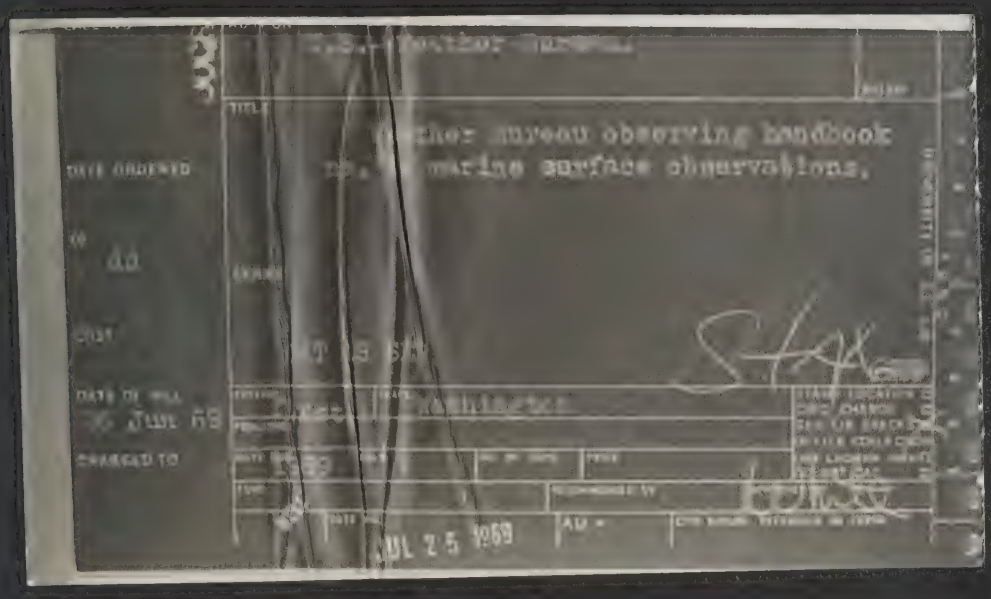
4.2 Select the appropriate figure from table 2 in appendix III and enter it in column 7.

5. Ship's Course and Speed Made Good During the Three Hours Preceding the Time of Observation.

5.1 General. In order to evaluate the 3-hour pressure change data in the eighth group ($D_S v_S$app) the course and speed of the ship during the 3-hour period must also be known.

5.2 Ship's Course (D_S). Select the code figure from table 15 in appendix III which most nearly represents the true course made good by the ship in the 3 hours preceding the time of the observation. Enter this value in column 24.

5.3 Ship's Speed (v_S). Select the code figure from table 16 in appendix III which most nearly represents the average speed made good by the ship in the 3 hours preceding the time of the observation. Enter this value in column 25.


weather bureau observing handbook
marine surface observations.
JUL 25 1969

3-13-62

PF U LC CAT SUP 48-52 53-57 58-62 63 54 65

CHAPTER 3

WIND

1. General.

1.1 Wind is measured in terms of velocity, a vector that includes speed and direction. True wind is the wind that is experienced by an observer standing still. When the ship is moving, an observer experiences the apparent wind, a resultant vector that combines the velocity of the ship with that of the wind. Apparent wind must be converted to true wind for meteorological reporting purposes.

1.1.1 Wind determined by the appearance of the sea surface is true wind.

1.1.2 Wind determined by the appearance of the ship's rigging or by a shipboard anemometer is apparent wind.

1.2 In the ship's code, the true wind is represented by the symbols dd for direction and ff for "force" or speed. These symbols appear in the fourth group of the code (Nddff). Wind shifts are also reported as a plain language addendum to the message.

2. True Wind Observing Methods.

2.1 True Wind Direction. True wind direction is estimated by observing the direction from which ripples, small waves and sea spray are coming, since they run with the wind.

2.1.1 The direction from which the waves are coming is most easily found by sighting along the wave crests and then turning 90° to face the advancing waves. The observer is then facing the direction from which the waves are coming.

2.1.2 The direction is determined to the nearest ten degrees with respect to true north.

2.2 True Wind Speed. The true wind speed is the average speed in knots of the wind blowing near the sea surface. Table 3-1 may be used to estimate the true wind speed based upon the condition of the sea surface. This table is based on several assumptions which should be considered in arriving at an estimate. These assumptions are:

a. That the wind has been blowing at a constant direction long enough to raise the appropriate sea.

TABLE 3-1. - Determination of Wind Speed by Sea Condition

Knots	Descriptive	Sea Conditions	Wind force (Beaufort)	Probable wave height in ft.
0-1	Calm	Sea smooth and mirror-like.	0	-
1-3	Light air	Scale-like ripples without foam crests.	1	1/4
4-6	Light breeze	Small, short wavelets; crests have a glassy appearance and do not break.	2	1/2
7-10	Gentle breeze	Large wavelets; some crests begin to break; foam of glassy appearance. Occasional white foam crests.	3	2
11-16	Moderate breeze	Small waves, becoming longer; fairly frequent white foam crests.	4	4
17-21	Fresh breeze	Moderate waves, taking a more pronounced long form; many white foam crests; there may be some spray.	5	6
22-27	Strong breeze	Large waves begin to form; white foam crests are more extensive everywhere; there may be some spray.	6	10
28-33	Near gale	Sea heaps up and white foam from breaking waves begin to be blown in streaks along the direction of the wind; spindrift begins.	7	14
34-40	Gale	Moderately high waves of greater length; edges of crests break into spindrift; foam is blown in well-marked streaks along the direction of the wind.	8	18
41-47	Strong gale	High waves; dense streaks of foam along the direction of the wind; crests of waves begin to topple, tumble, and roll over; spray may reduce visibility.	9	23
48-55	Storm	Very high waves with long overhanging crests. The resulting foam in great patches is blown in dense white streaks along the direction of the wind. On the whole, the surface of the sea is white in appearance. The tumbling of the sea becomes heavy and shocklike. Visibility is reduced.	10	29
56-63	Violent storm	Exceptionally high waves that may obscure small and medium-sized ships. The sea is completely covered with long white patches of foam lying along the direction of the wind. Everywhere the edges of the wave crests are blown into froth. Visibility reduced.	11	37
64-71	Hurricane	The air is filled with foam and spray. Sea completely white with driving spray; visibility very much reduced.	12	45

b. That the location is well removed from any land.

2.2.1 Some factors which will cause the speed given by the table to be too low are:

a. Winds which have just sprung up.

b. Off-shore winds within sight of land.

c. Moderate or heavy precipitation, by smoothing the sea surface.

2.2.2 Some factors which will cause the speed given by the table to be too high are:

a. Waves running into shallow water.

b. A decreasing wind speed.

2.2.3 The observer should use his own judgment in accepting or modifying the wind speeds given in Table 3-1.

3. Apparent Wind Observing Methods.

3.1 Apparent Wind Direction. Apparent wind direction is estimated to the nearest ten degrees off the ship's bow in the direction from which the wind is blowing.

3.1.1 If the ship is equipped with a wind vane, the apparent wind direction is the direction toward which the vane is pointing, or the direction dial reading if the wind vane is connected to a remote readout.

3.1.2 If the ship does not have a wind vane, the observer may determine the apparent wind direction by standing in an exposed location on the windward side of the ship and facing directly into the wind.

3.1.3 When weather conditions prohibit standing in the wind, the apparent direction may be determined from flags, pennants or the ship's smoke. The apparent direction will be opposite to the direction in which the flag, pennant or smoke is streaming.

3.2 Apparent Wind Speed. Apparent wind speed is estimated or measured in knots at a point on a moving ship.

3.2.1 If the ship is equipped with an anemometer, the readout dial indicates apparent wind speed. When speeds are read from an anemometer

dial, the dial should be observed for about one minute to determine an average speed.

3.2.2 Apparent wind speed may be estimated by noting the "feel" of the apparent wind or the effects of the apparent wind on the ship's smoke, flags, rigging, or loose objects on deck.

Table 3-2. Apparent Wind Speed

Speed (knots)	Indication
Less than 1------	Calm; smoke rises vertically.
1 - 3----------	Smoke drifts from funnel.
4 - 6----------	Wind felt on face.
7 - 10----------	Wind extends light flag.
11 - 16----------	Wind raises dust and loose paper on deck.
17 - 21----------	Wind waves and snaps flag briskly.
22 - 27----------	Whistling in rigging.
28 - 33----------	Inconvenience felt walking against wind.
34 - 40----------	Walking becomes difficult.

4. Converting Apparent Wind to True Wind.

4.1 Apparent wind has little value in navigation or meteorological operations. The ship's course and speed must be eliminated from the apparent wind to obtain true wind.

4.1.1 When using the conversion methods in the following paragraphs, these general guidelines should be used as a check on the true wind.

a. The true wind direction is always on the same side as, but farther from the bow than the apparent direction.

b. When the apparent direction is aft of the beam, the true speed is greater than the apparent speed.

c. When the apparent direction is forward of the beam, the true speed is less than the apparent speed.

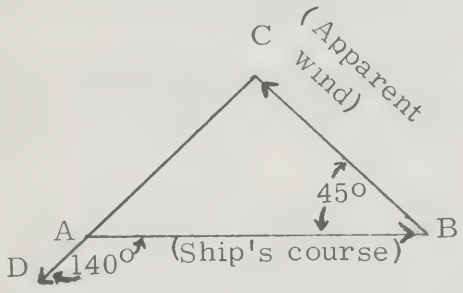
4.1.2 Use one of the following methods for converting apparent wind to true wind.

a. A vector diagram (Fig. 3-1).

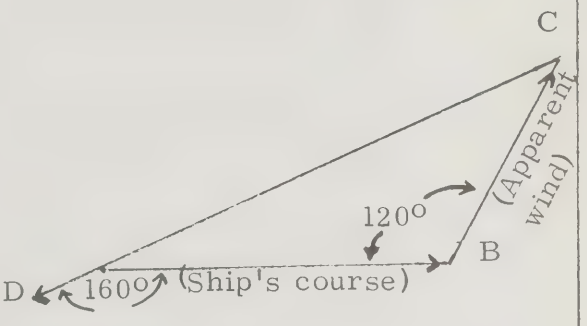
b. W.B. Form 1209 (Fig. 3-2).

c. A plotting board (Fig. 3-3).

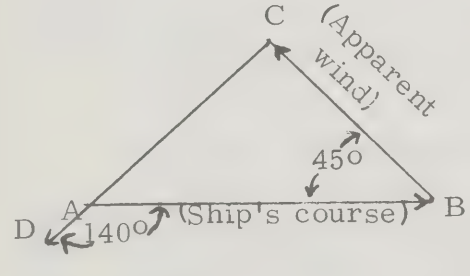
(a)
Ship's course, 090°,15kts.
Apparent wind, 045° off starboard bow, 10kts.
True wind, 140°+090°=230°, 11kts.



(b)
Ship's course, 210°,15kts.
Apparent wind, 120° off starboard bow, 10kts.
True wind, 160°+210°=370°(-360)= 010°, 22kts.



(c)
Ship's course, 090°, 15kts.
Apparent wind, 045° off port bow, 10kts.
True wind, 090°(+360°)-140° =310°, 11kts.



(d)
Ship's course, 210°, 15kts.
Apparent wind, 120° off port bow, 10kts.
True wind, 210°-160°=50°, 22kts.

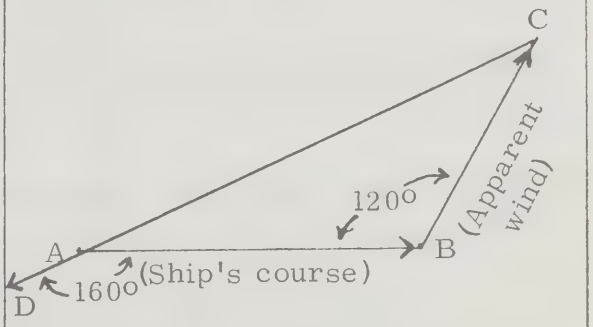


Figure 3-1. Vector Diagram Examples.

4.2 Vector Diagram. Refer to Figure 3-1 and construct a vector diagram as follows.

a. Draw a vector AB representing the speed of the ship on a scale of 1/4 inch to the knot or other convenient unit.

b. From the point B, draw a vector BC, equal in length to the apparent wind speed, making an angle with vector AB equal to the apparent wind direction relative to the ship's bow.

c. Join points A and C and extend the joining line beyond A to D. Measure the length of AC. This length represents the true wind speed.

d. Measure the angle DAB. This angle represents the true wind direction off the ship's bow. If the apparent wind is off the starboard bow, add the angle to the ship's true heading to obtain true wind direction. If the apparent wind is off the port bow, subtract the angle from the ship's true heading. If the angles are added, subtract 360° when the result exceeds 360°. If the angle is to be subtracted from the ship's heading and it is greater than the ship's true heading, add 360° to the ship's heading before the subtraction. The angle obtained will be the true wind direction with respect to true north.

4.3 Use of WB Form 1209, Surface Wind at Sea. WB Form 1209 is a chart used to compute the true wind using the apparent wind and ship's course and speed as arguments. See Figure 3-2.

4.3.1 A scale in knots is printed on concentric circles. If the observed apparent wind speed exceeds the scale, double or triple the printed values. The radial lines represent true direction. The black degree markings represent degrees off the ship's bow for plotting the apparent wind. A separate scale of knots is provided on a slide for use with the form.

4.3.2 Use the following four steps to obtain true wind:

a. Select the radial line corresponding to the angle, in degrees off the bow (port or starboard), from which the wind is blowing and plot a point on it at a distance from the center (scale printed on concentric circles) equal to the speed of the apparent wind in knots.

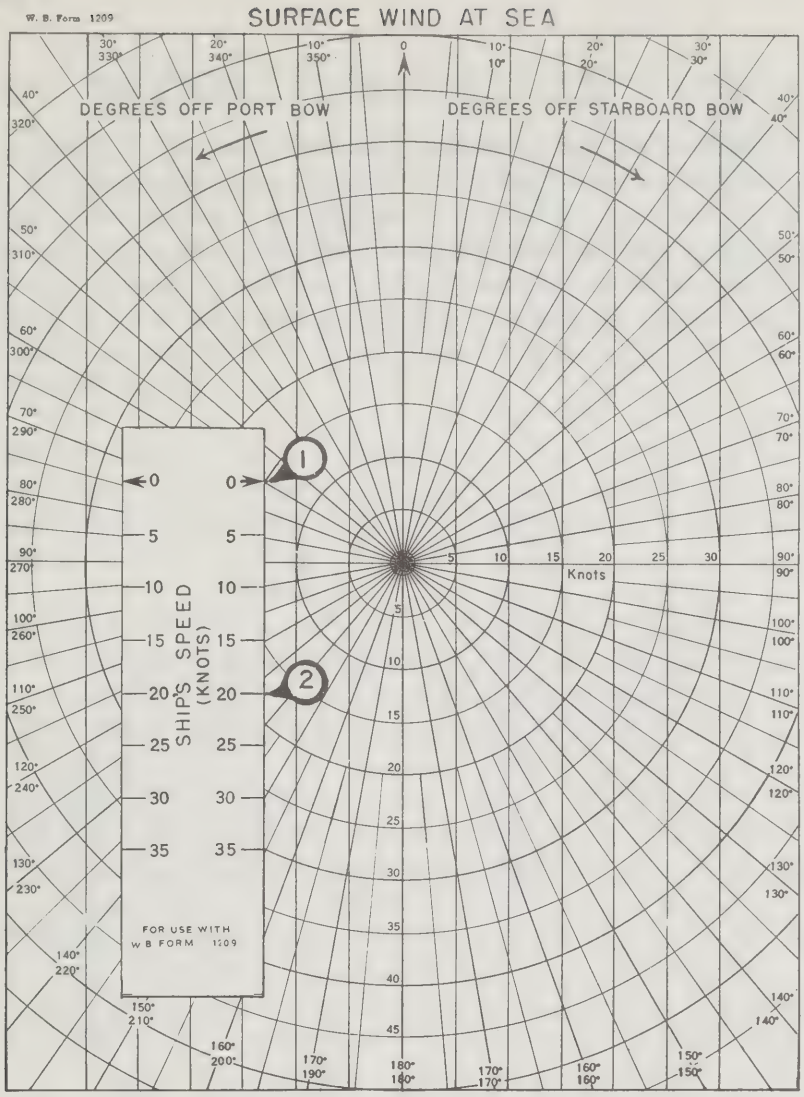


Figure 3-2. Surface Wind at Sea, WB Form 1209.

b. Place the 0 (arrow point) of the ship's speed slide at the point plotted in a. Measure the ship's speed vertically downward toward the bottom of the chart. Plot this point on the chart.

c. Read the wind speed corresponding to the point plotted in b. Estimate the nearest knot between the concentric circles. This value is the true wind speed.

d. Read the angle, from the figures printed in green (bottom figures), on the radial line from the center through the point plotted in b. Add this angle to the ship's true heading in degrees to obtain the true wind direction. If the total exceeds 360°, subtract 360° from it.

4.4 Plotting Board Method for Computing True Wind.

4.4.1 Apparent wind which has been estimated, or measured with an anemometer, may be converted to true wind on a shipboard wind plotter (see Fig. 3-3). A red arrow is at the top of the board. The horizontal lines represent a scale of 2 knots per line. When the speeds to be used exceed the printed scale, double or triple the values on the scale. The vertical lines are used as guides to line two plotted points up vertically.

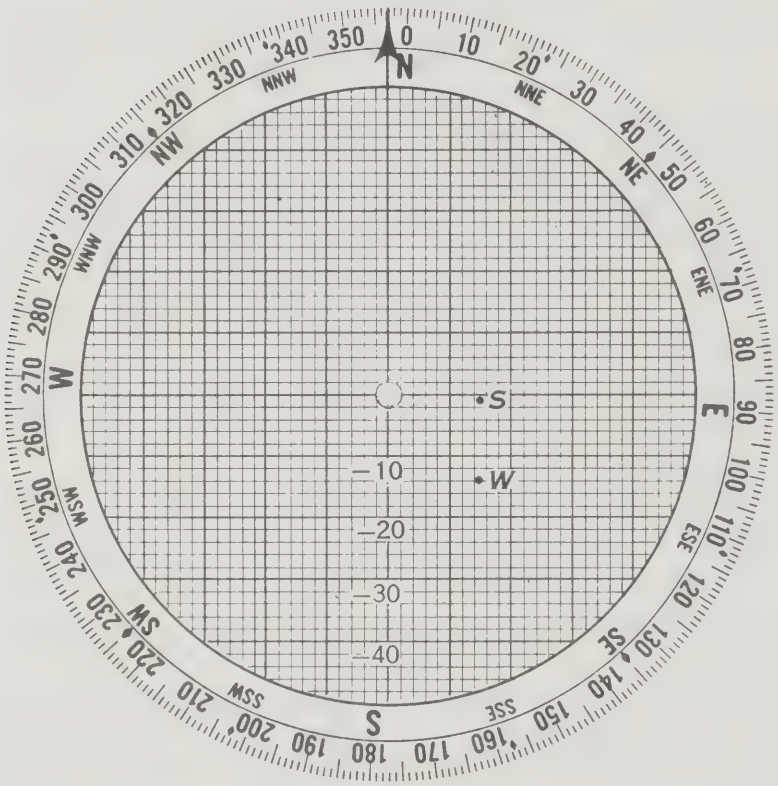


Figure 3-3. Shipboard Wind Plotter.

4.4.2 Proceed as follows:

a. Convert apparent wind direction relative to the bow to an apparent direction relative to true North. This is done by adding starboard directions to the ship's true heading or subtracting port directions from the ship's heading. If the ship's heading in degrees is smaller than a port bow apparent wind direction, add 360° to the ship's true heading before subtracting. Results greater than 360° which are obtained by adding should be reduced by 360°.

b. Rotate the plotting board until the ship's true heading appears at the arrow. Measuring vertically downward from the center of the board plot a point at the ship's speed. Mark the point "S".

c. Rotate the board until the apparent wind direction relative to true North appears at the arrow. Using the same scale as for the ship's speed, measure vertically downward and plot a point for the apparent wind speed. Label the point "W".

d. Rotate the protractor until the "S" is directly above the "W". Read true wind direction at the arrow. The distance between the two dots is the true wind speed.

5. Observing Wind Shifts.

5.1 Wind shifts should be reported in the first scheduled observation after their occurrence. Reporting procedures are covered in ¶7.4.

5.1.1 A wind shift is defined as a change in the direction of the true wind of 45° or more which takes place in less than 15 minutes, followed by a sustained speed of 10 knots or more.

5.2 When the wind shifts, note the time of the shift and the wind direction before and after a shift.

5.3 Meteorological Features of a Wind Shift.

5.3.1 Wind shifts are often associated with the passage of a cold front. The following phenomena may be experienced when a cold front, moving from west to east in the Northern Hemisphere passes a point:

a. Gusty winds shifting in a clockwise direction

b. Rapid drop in dewpoint

c. Drop in air temperature

d. Rise in pressure

e. Thunderstorms or snow squalls and a change of cloud heights after the wind shift.

5.3.2 In the Southern Hemisphere, the same phenomena would occur except that the wind direction would shift counterclockwise.

5.3.3 On a moving ship, the order of the phenomena will vary depending upon the course and speed of the ship, e.g., a ship may overtake a cold front from behind and encounter a rise in dewpoint, a fall in pressure, etc.

5.3.4 Wind shifts will also occur when the ship passes through a transitional zone near the equator known as the Intertropical Convergence Zone (ITCZ). This is an area about 50 to 100 miles wide where the southeast trade winds of the Southern Hemisphere merge with the northeast trades of the Northern Hemisphere. The zone moves north and south with the summers and usually stays within 15 degrees of the equator.

5.3.5 As a ship moves from north to south across the ITCZ, winds will change from NE to SE trades. Greater changes of wind direction and speed will be observed during tropical storm development. At these times and to some extent when both trade wind systems are strong in the zone, showers and squalls will occur.

6. Squalls.

6.1 A squall is defined as a sudden increase of wind speed by at least three stages of the Beaufort scale (16 knots or more) rising to force 6 (22 knots) or more and lasting for at least one minute.

6.1.1 Squalls are considered a weather phenomenon and are reported in the "Present Weather" portion of the ship's code. Reporting procedures for squalls are discussed in ¶5.2.2.2.

7. Encoding and Entering True Wind Data on ESSA Form 72-1.

7.1 True wind data are entered on ESSA Form 72-1 in Columns 9, 10 and 40.

7.2 True Wind Direction (dd). The true wind direction code figure is entered in column 9. Table 4 in appendix III contains the code figures. Each number represents the wind direction to the nearest ten degrees. Note the following rules for the code figure.

a. "00" is used only for calm and "36" is used for a direction 355° to 4°.

b. When the wind speed exceeds 99 knots, the number 50 is added to the "dd" code figure. (See also ¶7.3.2 below).

7.3 True Wind Speed (ff).

7.3.1 True wind speed, in knots, is entered in Column 10 using two figures, e.g., 6 knots is entered "06". "Calm" is entered "00".

7.3.2 When the wind speed exceeds 99 knots, subtract 100 from the value and enter the remainder in Column 10. At the same time, modify the direction in Column 9 as specified in ¶7.2 a. For example, a true wind of 037°, 100 knots is entered in Column 9 as "54" (04 + 50) and in Column 10 as "00" (100 - 100).

7.4 Wind Shifts (Plain Language).

7.4.1 When wind shifts are observed, enter a remark in Column 40 to be transmitted with the next scheduled observation. The remarks should contain the following items:

a. The words "WIND SHIFT" followed by the time GMT in hours and minutes that the shift began.

b. The true wind direction before and after the shift.

c. When transmitted, the remark follows the last code group in the message.

Example: WIND SHIFT 0238 SW TO NW.

CHAPTER 4

VISIBILITY

1. General.

1.1 Visibility. Visibility is a term that denotes the greatest distance from an observer that an object of known characteristics can be seen and identified.

1.2 Prevailing Visibility. Prevailing visibility is defined as the highest visibility that is equalled or exceeded over sectors of the horizon which, when combined, total one-half or more of the horizon circle. When the visibility is uniform in all directions "visibility" and "prevailing visibility" are the same.

1.3 Prevailing visibility is reported in the fifth group of the Ship's Code (VVwwW), represented symbolically by the letters VV.

2. Determining Visibility.

2.1 Whenever possible, estimate visibility using objects whose distance is known. Estimating the distance to a ship may be based on its apparent size and the portion visible. Visibility may also be estimated by determining the distance of a passing vessel by means of radar. Table 4-1 is a guide to determining distance from the observer to the horizon and objects such as a ship whose height is known. For example, the horizon, from a height of 40 feet above sea level, appears at a distance of 7.6 nautical miles.

Table 4-1. Distance to Objects on the Horizon at Sea (nautical miles)

Height of observer's eyes above sea level (feet)	Height of object above sea level (feet)														
	0	10	20	30	40	60	80	100	150	200	300	400	600	800	1,000
10	3.8	7.2	8.7	9.9	10.8	12.5	13.9	15.1	17.7	19.8	23.5	26.5	31.6	36.0	39.8
15	4.6	8.0	9.5	10.7	11.6	13.3	14.7	15.9	18.5	20.6	24.3	27.3	32.4	36.8	40.6
20	5.4	8.7	10.2	11.4	12.3	14.0	15.4	16.6	19.2	21.3	25.0	28.0	33.1	37.5	41.3
25	6.0	9.3	10.8	12.0	12.9	14.6	16.0	17.2	19.8	21.9	25.6	28.6	33.7	38.1	41.9
30	6.6	9.9	11.4	12.6	13.5	15.2	16.6	17.8	20.4	22.5	26.2	29.2	34.3	38.7	42.5
35	7.1	10.4	11.9	13.1	14.0	15.7	17.1	18.3	20.9	23.0	26.7	29.7	34.8	39.2	43.0
40	7.6	10.8	12.3	13.5	14.4	16.1	17.5	18.7	21.3	23.4	27.1	30.1	35.2	39.6	43.4
45	8.0	11.3	12.8	14.0	14.9	16.6	18.0	19.2	21.8	23.9	27.6	30.6	35.7	40.1	43.9
50	8.5	11.7	13.2	14.4	15.3	17.0	18.4	19.6	22.2	24.3	28.0	31.0	36.1	40.5	44.3
60	9.3	12.5	14.0	15.2	16.1	17.8	19.2	20.4	23.0	25.1	28.8	31.8	36.9	41.3	45.1
70	10.0	13.2	14.7	15.9	16.8	18.5	19.9	21.1	23.7	25.8	29.5	32.5	37.6	42.0	45.8
80	10.7	13.9	15.4	16.6	17.5	19.2	20.6	21.8	24.4	26.5	30.2	33.2	38.3	42.7	46.5
90	11.4	14.5	16.0	17.2	18.1	19.8	21.2	22.4	25.0	27.1	30.8	33.8	38.9	43.3	47.1
100	12.0	15.1	16.6	17.8	18.7	20.4	21.8	23.0	25.6	27.7	31.4	34.4	39.5	43.9	47.7

2.2 Estimation of visibility will be based on the sharpness with which the object stands out. Sharp outlines, with little or no blurring of color, indicate that the visibility is much greater than the distance to the object. Blurred or indistinct objects indicate that the visibility is about equal to the distance to the objects.

2.3 When the visibility is not the same in all directions, the highest value common to one-half or more of the horizon circle should be determined. For example, if fog limits the visibility in the NE and SE quadrants of the horizon circle to one mile, while the visibility in the SW and NW quadrants is six miles, the maximum visibility common to one-half of the horizon circle is six miles.

2.4 Figure 4-1 illustrates non-uniform visibility which may be the result of squalls in one quadrant of the horizon circle, light showers and haze in another and haze only in the third quadrant. The maximum visibility common to one-half of the circle is three miles.

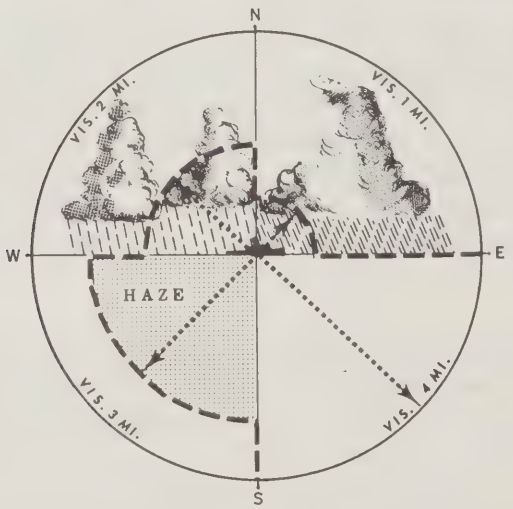


Figure 4-1. Non-Uniform Visibility

3. Encoding and Entering Prevailing Visibility Data (VV) on Form 72-1.

3.1 Select the code figure from table 5 in appendix III corresponding to the prevailing visibility and enter the figure in column 11.

CHAPTER 5

WEATHER

1. General.

1.1 Weather is encoded in the fifth group of the ship's code (VVwwW) and is represented by the symbols ww (present weather) and W (past weather). Weather data are entered in columns 12 and 13, and weather notes are entered in column 40 on ESSA Form 72-1.

1.2 Weather elements of an observation are thunderstorms, lightning, waterspouts, squalls, any form of precipitation, fog, haze, smoke and dust. Rainbows, halos, coronas and auroras are not included in the weather report but may be recorded in the remarks column of Form 72-1.

1.3 Clouds are not described here. They are considered separately in Chapter 8.

2. Definitions of Weather Phenomena.

2.1 Thunderstorms and Lightning. A thunderstorm is regarded as occurring at the ship when thunder has been heard within the past 15 minutes. A thunderstorm ends 15 minutes after the last thunder is heard. Lightning is an electrical discharge that occurs within a cloud, from cloud to cloud, or from cloud to sea. Distant lightning is lightning that occurs so far from the observer that the resulting thunder cannot be heard.

2.1.1 The intensity of a thunderstorm is classified as slight, moderate or heavy, depending upon the appearance of the storm from the point of observation. Viewed from the ship, a thunderstorm may be classified as slight throughout its history, or it may be classified during its passage by the ship as slight while far away, moderate and heavy as it approaches the ship, and moderate or slight as it moves on. Each classification is described below:

a. Slight Thunderstorm. Thunder is not loud and lightning occurs within the cloud at intervals of a minute. Rainfall is light or moderate and small hail may also fall. Any sudden increase in wind speed is of short duration and the wind speed does not exceed 26 knots during the storm.

2.2 Estimation of visibility will be based on the sharpness with which the object stands out. Sharp outlines, with little or no blurring of color, indicate that the visibility is much greater than the distance to the object. Blurred or indistinct objects indicate that the visibility is about equal to the distance to the objects.

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Figure 4-1. Non-Uniform Visibility

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a. Slight Thunderstorm. Thunder is not loud and lightning occurs within the cloud at intervals of a minute. Rainfall is light or moderate and small hail may also fall. Any sudden increase in wind speed is of short duration and the wind speed does not exceed 26 knots during the storm.

b. Moderate Thunderstorm. Loud peals of thunder occur at brief intervals, and frequent flashes of lightning occur from cloud to sea, as well as from cloud to cloud. Rain is moderate to heavy and any fall of hail is light or moderate. An on-rush of wind may precede the storm, with a speed as high as 35 knots. Extensive masses of churning dark clouds move rapidly across the sky.

c. Heavy Thunderstorm. Sharp and pronounced thunder and lightning occur almost continuously. Heavy rain occurs, sometimes accompanied by hail. The wind preceding and accompanying the storm may reach a speed in excess of 35 knots. A rapid drop in temperature occurs, sometimes as much as 10°C. in five minutes.

2.2 Waterspouts and Squalls.

2.2.1 Waterspouts occur when conditions are favorable for intense thunderstorm activity. The distinguishing feature is the funnel-shaped appendage that hangs from the base of the cloud and reaches the sea surface. Appendages that do not reach the surface are termed "funnel clouds". Over land the terms are "tornado" and "funnel cloud".

2.2.2 A squall is a sudden increase of wind by at least three stages of the Beaufort scale (16 knots or more), rising to force 6 (22 knots) or more, and lasting for at least one minute. Similar fluctuations will occur at succeeding intervals. When precipitation occurs with squalls, the precipitation takes precedence for reporting purposes.

2.3 Precipitation. Precipitation includes all forms of moisture that fall to the earth's surface -- rain, drizzle, snow, hail, ice pellets, and ice crystals. Precipitation is classified by its character, intensity, and type.

2.3.1 Character. Precipitation character is described below:

a. Continuous. Precipitation which begins and ends gradually and maintains a steady rate of fall. Usually associated with stratiform clouds. Any increase or decrease of intensity is gradual.

b. Intermittent. Intensity changes gradually, and precipitation stops and starts at least once within the hour before the observation.

c. Showery. Precipitation starts and ends abruptly. Rapid changes in intensity occur often. Showers are associated with cumuliform clouds, especially swelling cumulus and cumulonimbus.

d. Combinations. Showers may occur in combination with continuous or intermittent precipitation. Under these conditions, the precipitation does not always stop between showers. Instead, precipitation is marked by sudden increases and decreases in intensity as the showers abruptly begin and end. When such combinations occur, the observer should encode the character having the highest code figure.

2.3.2 Intensity. The intensity of precipitation may be determined by its rate of fall, by the amount it reduces the visibility, or both. The intensity is classified as light, moderate or heavy. Table 5-1 is used as a guide to determine the intensity of rain. Table 5-2 is for snow intensities.

Table 5-1. --Intensity of Rain

Slight	Individual drops are easily identifiable; spray over hard surfaces is slight; pools form very slowly; over 2 minutes may be required to wet decks and similar dry surfaces.
Moderate . .	Individual drops are not clearly identifiable; some spray over hard surfaces; pools form rapidly.
Heavy.	Rain seemingly in sheets; individual drops are not identifiable; heavy spray to height of several inches is observable over hard surfaces; visibility is greatly reduced.

Table 5-2. --Intensity of Snow

Slight	Visibility 1, 100 yards (1, 000 meters) or more.
Moderate . .	Visibility less than 1, 100 yards (1, 000 meters), but not less than 550 yards (500 meters).
Heavy.	Visibility less than 550 yards (500 meters).

2.3.3 Types. Precipitation is classified as liquid, freezing or frozen. These types are described below:

a. Liquid Precipitation. Liquid precipitation is classified as drizzle or rain as follows:

1. Drizzle. Very small and uniformly dispersed droplets that appear to float in the air and to follow very light air currents. Drizzle usually falls from low stratus clouds and is frequently accompanied by low visibility and fog.

2. Rain. Falling drops of liquid water that are larger than those in drizzle. Rain, as used in this manual, does not include drizzle and freezing rain.

b. Freezing Precipitation. Freezing precipitation is classified as freezing rain or freezing drizzle by the following characteristics:

1. Freezing Rain. Rain that falls in liquid form and freezes upon impact with exposed surfaces. When the fall is so rapid that runoff occurs, the ice will usually appear as glaze.

2. Freezing Drizzle. Drizzle that freezes upon impact with exposed objects.

c. Frozen Precipitation. Frozen, or solid, precipitation is classified as follows:

1. Ice Pellets. Precipitation of transparent or translucent pellets of ice, which are spherical or irregular, rarely conical, and have a diameter of 0.2 in. or less. They are of two types; type (a) consists of frozen raindrops or largely melted and refrozen snowflakes ("sleet" in the U. S.). Type (b) consists of pellets of snow encased in a thin layer of ice.

2. Hail. Ice balls or stones, ranging in diameter from that of medium-size raindrops to an inch or more. They may fall detached or frozen together into irregular, lumpy masses. They are composed either of clear or alternating clear and opaque layers. Hail often accompanies thunderstorm activity. Surface temperatures are usually above freezing when hail occurs. The size is based on the diameter, in inches, of normally shaped hailstones.

3. Snow. White or translucent ice crystals chiefly in complex branched hexagonal form (six-pointed stars), often mixed with simple crystals. Snow occurs under conditions that are similar, temperature excepted, to those of corresponding forms of rain.

4. Snow Pellets (Soft Hail). White, opaque, round, or occasionally conical kernels of snow-like consistency, 1/16 to 1/4 inch in diameter. They are crisp and easily compressible, and they rebound or burst when striking hard surfaces. They occur almost exclusively in showers.

5. Snow Grains (Granular Snow). The solid equivalent of drizzle. They take the form of minute, branched, star-like snowflakes, or of very fine simple crystals. At times they have the appearance of rime. Snow grains occur under conditions similar to those of drizzle, except that the temperature is lower.

6. Ice Prisms. Small unbranched ice needles or prisms in the form of rods or plates that have a descending motion and that may be observed when the sky is clear. Ice prisms are associated with halo phenomena and with very low temperatures in stable air masses from the polar regions.

2.4 Fog and Rime.

2.4.1 Fog is composed of minute droplets suspended in the atmosphere. These droplets have no visible downward motion. Fog differs from clouds only in the fact that fog is based at the surface and clouds are based aloft. Fog is distinguished from haze by its dampness and grey color. Fog rarely exists when the difference between the temperature and the dew point (see Chapter 7) is more than 2.5°C. Fog always extends to a depth greater than 6 feet on land or 33 feet at sea (in practice, the observer's eye level while standing on land or on a ship's bridge), thereby reducing prevailing visibility to less than 1/2 n. mi. (1100 yards). When the visibility or depth criterion is not met, see a. b. and c. below:

a. Light Fog. Fog which extends above eye level but only reduces the visibility to less than 6 n. mi. but not less than 1/2 n. mi.

b. Shallow Fog. Fog which does not extend above eye level and, therefore, does not reduce visibility below 1/2 n. mi. However, the density of the fog is such that it would reduce visibility observed from a point within the fog to less than 1/2 n. mi.

c. Fog Bank. Fog which is not at the ship, extending to a depth greater than eye level, within which the visibility would be less than 1/2 n. mi.

2.4.2 Rime. Rime is the frozen deposit left on exposed surfaces by liquid fog when air temperatures are below freezing.

2.5 Haze, Smoke, and Dust. Haze, smoke, and dust suspended in the atmosphere, may be observed near land. While there are no restrictions on the visibility in these phenomena, the prevailing visibility should be lower than normal.

2.5.1 Haze. Haze resembles a uniform veil with a bluish tinge when viewed against the sun or clouds at the horizon. When the phenomenon seems to be fog, but the difference between the temperature and dew point is too great (4° or more) the phenomena is probably haze. No visibility limits are involved.

2.5.2 Smoke present in the atmosphere (from distant forest fires or industrial centers) will impart a reddish tinge to the sun. No visibility limits are involved.

2.5.3 Dust suspended in the atmosphere imparts a tan or grey hue to distant objects and the sun appears pale with a yellow tinge. No visibility limits are involved.

2.6 Miscellaneous Phenomena. Solar or lunar halos, coronas, rainbows, fogbows and auroras are defined in the International Cloud Atlas. They are not operationally significant and no provision has been made for reporting their occurrence in the ship's code.

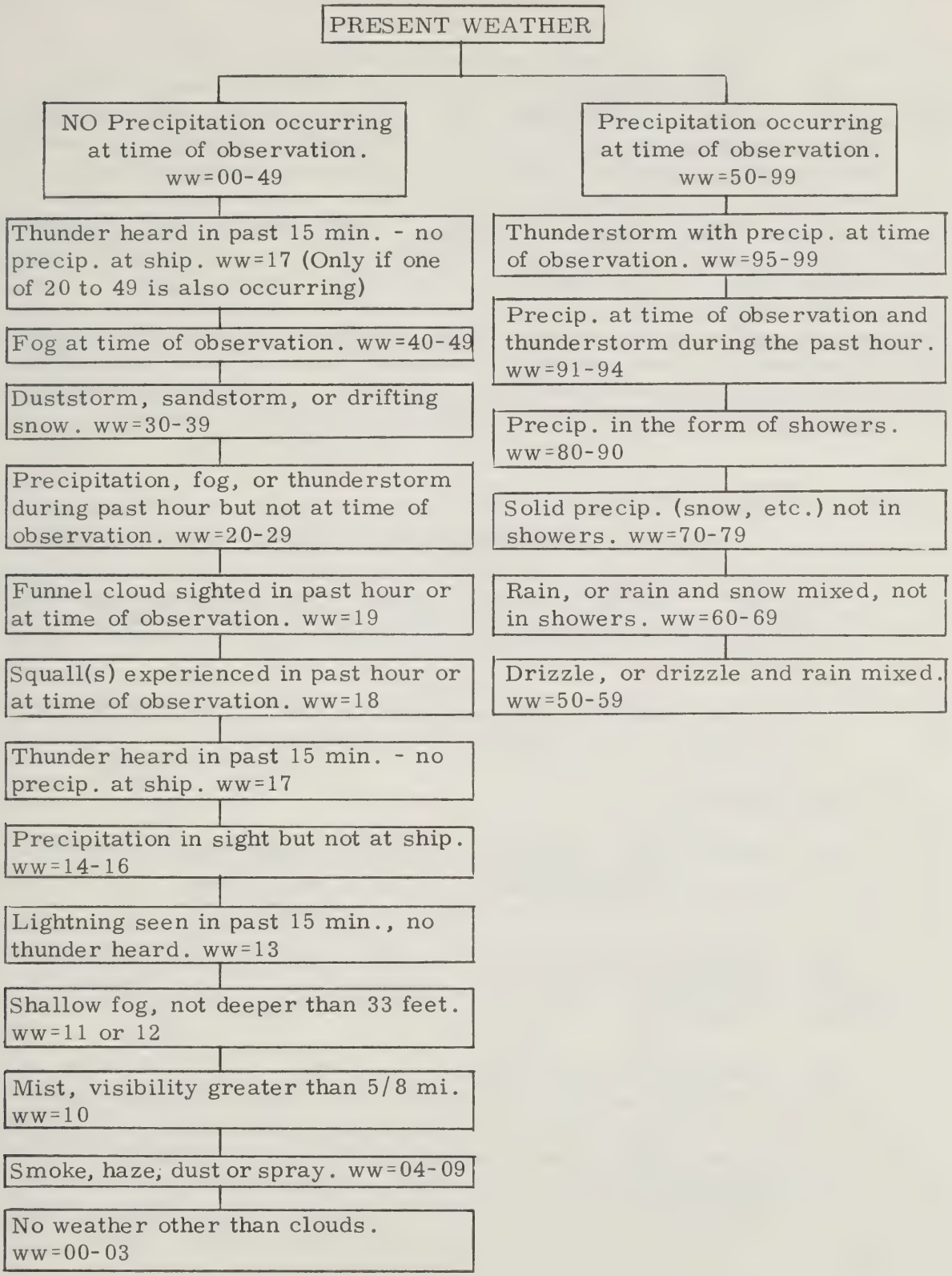
3. Observing Weather Phenomena.

3.1 The observer should keep track of weather phenomena occurring between observation times. Brief notes should be made of such events as the time thunder is heard, time of beginning and ending of precipitation or fog producing visibilities less than 1/2 n. mi. etc.

3.2 When weather phenomena are occurring at observation time, the observer should determine characteristics of the phenomena as specified in section 2 and in the ww code. For example, if fog is occurring, note whether the fog has decreased or increased in the past hour, the fog depth and visibility.

4. Encoding and Entering Present Weather and Past Weather Data on ESSA Form 72-1.

Table 5-3. Guide for Selection of Present Weather Code Figures.



4.1 Data on weather phenomena are encoded in the fifth group of the ship's code (VVwwW) represented symbolically by ww (present weather) and W (past weather). On ESSA Form 72-1, these coded data are entered in columns 12 and 13. Plain language weather notes are entered in column 40 for climatological purposes and should not be transmitted.

4.2 Present Weather Code Figures. Present weather code figures apply to phenomena occurring now and in the past hour. Code figures are contained in table 6, appendix III.

4.2.1 In general, the highest numerical ww code figure is selected for entry in column 12. The exception is that code figure 17 takes precedence over code figures 20 and 49 inclusive. The observer will be assisted in making the proper code selection by using Table 5-3 as follows:

a. Start at the top of the table.

b. If precipitation is occurring at the ship at the time of observation, check downward on the right hand side until an applicable group of code figures is encountered. Then check the code table within the range given in the box and select the highest figure applicable.

c. If precipitation is not occurring at the ship follow the same procedure as in b. down the left hand side.

4.3 Past Weather.

4.3.1 Past weather is included in the ship's code to fill in important weather events that occur between standard observations. Code figures for past weather are contained in table 7 in appendix III.

4.3.2 When observations are made at 6-hourly intervals, past weather is selected from events that have occurred during the 6-hour interval between observations.

4.3.3 When observations are made at times other than standard hours, the selection of past weather is made from events occurring since the last standard hour, regardless of any intervening observations. For example, if observations are taken hourly, which may be requested during a tropical storm, past weather reported each hour would cover the following time intervals: at 0600 GMT, 6 hours; at 0700, 1 hour; at 0800, 2 hours; at 0900, 3 hours; at 1000, 4 hours; at 1100, 5 hours, and at 1200, 6 hours.

4.3.4 The past weather code figure should be selected so that it represents the general character of the weather which prevailed between the time of previous standard hour and the time of onset of the present weather reported by ww. When more than one W code figure applies, select the highest applicable W code figure which is not also represented by the selected ww code figure.

4.4 Weather Notes, Column 40. In general, the remarks column (or the blank portion of the reverse side of the form when the column is too small) should be used as a continuous log of the occurrence of phenomena. The selection of present weather and past weather code figures depends upon times of occurrence, visibilities and other factors which may be recorded for use at observation times. These notes also are useful for climatological purposes.

4.4.1 In order to conserve space and simplify note-taking, use of the abbreviations in table 5-4 is recommended.

Table 5-4. Selected Letter Abbreviations for Weather Notes
(Use these letters when it is convenient to do so)

Word	Abbreviation
Thunder	T
Rainshower	RW
Snowshower	SW
Freezing Rain	ZR
Freezing Drizzle	ZL
Ice Pellets (sleet)	IP
Hail	A
Snow	S
Rain	R
Drizzle	L
Fog	F
Haze	H
Smoke	K
Dust	D
Began	B (Time GMT)
Ended	E (Time GMT)

Do not abbreviate Waterspout or Funnel Cloud.

CHAPTER 6

PRESSURE

1. General.

1.1 Pressure as used in this Handbook means atmospheric pressure. Atmospheric pressure is measured by barometers, of which there are two types in general use - the mercury barometer and the aneroid barometer. A continuous record of pressure is obtained by an aneroid barograph. The mercury barometer is not generally used aboard merchant vessels and, therefore, only a brief description of this instrument is included here.

1.1.1 The mercury barometer is a glass tube about three feet long, closed at one end, filled with mercury, and inverted with the open end immersed in a cistern of mercury. With the cistern surface exposed to atmospheric pressure, the height of the mercury column varies with that pressure.

1.1.2 Other factors cause the height of the mercury column to vary. Two factors are the force of gravity, which varies with latitude, and the density of the mercury, which varies with temperature. Two other corrections must be made before sea level pressure is obtained. These are "instrument error" and "barometer height".

1.2 The aneroid barometer requires no correction for gravity because of its design principle. The actuating element is a metal bellows which has been partially evacuated of air and hermetically sealed.

1.2.1 Aneroid barometers are convenient to use but do not retain their calibration over long periods of time and should be compared frequently with a standard barometer. They must be protected from shocks or other violent motions.

1.2.2 Aneroid barometers used for weather observing should be mounted in the chart room or wheelhouse at eye level in a location which is away from vibration, rapid temperature changes, and heat sources such as steam pipes or electric light bulbs.

1.3 The Port Meteorological Officer will determine the correction for your barometer and post it on or near the barometer face. The correction will include the instrument error and the correction for the barometer's height above the mean water line of the ship. Applying the posted value to each reading will yield sea level pressure. The correction should be

renewed every three months. If the posted correction has a date more than three months old, contact a Port Meteorological Office or one of the other offices listed in Appendix II and request a barometer comparison.

2. Aneroid Barometers.

2.1 Pressure is indicated on an aneroid barometer by the position of a hand on a graduated dial. Aneroids have dials graduated at intervals equivalent to millibars, inches or millimeters of mercury. Figure 6-1 shows an aneroid barometer scaled in both millibars and inches.

2.2 Reading Aneroid Barometers. To determine sea level pressure from an aneroid barometer take the following steps:

a. To avoid errors of parallax when the aneroid barometer is read, the line of sight should be perpendicular to the hand on the instrument. If the aneroid has a mirror on the surface of the dial, look at the hand from an angle such that the image is hidden behind the hand.

Figure 6-1. Aneroid Barometer, W.B. Model G 122.

b. Read to the nearest 0.1 millibar, 0.01 inch, or 1 millimeter. Estimate between whole scale graduations. Apply the post correction. Example:

	millibars	inches
Barometer as read----------	1011.9	29.88
Posted correction----------	-2.4	-0.07
Sea-level pressure----------	1009.5	29.81

3. Barographs.

3.1 General. The barograph is a continuous recorder of atmospheric pressure. A pen moves across the barogram approximately three-quarters of an inch for each 10 millibars. The barograph consists of an aneroid pressure unit, suitable linkage and a clock driven drum upon which a chart (barogram) is fastened. Figures 6-2 and 6-3 are the two types of barographs furnished to selected ships by the Weather Bureau.

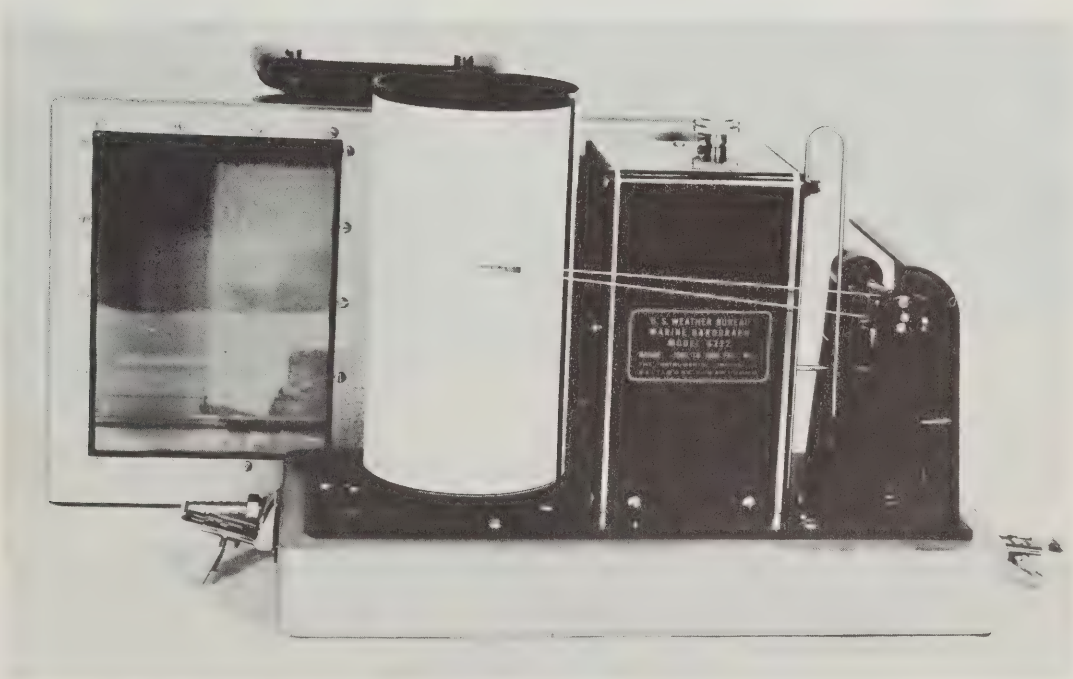


Figure 6-2. Barograph, Marine, W.B. Model G 222.

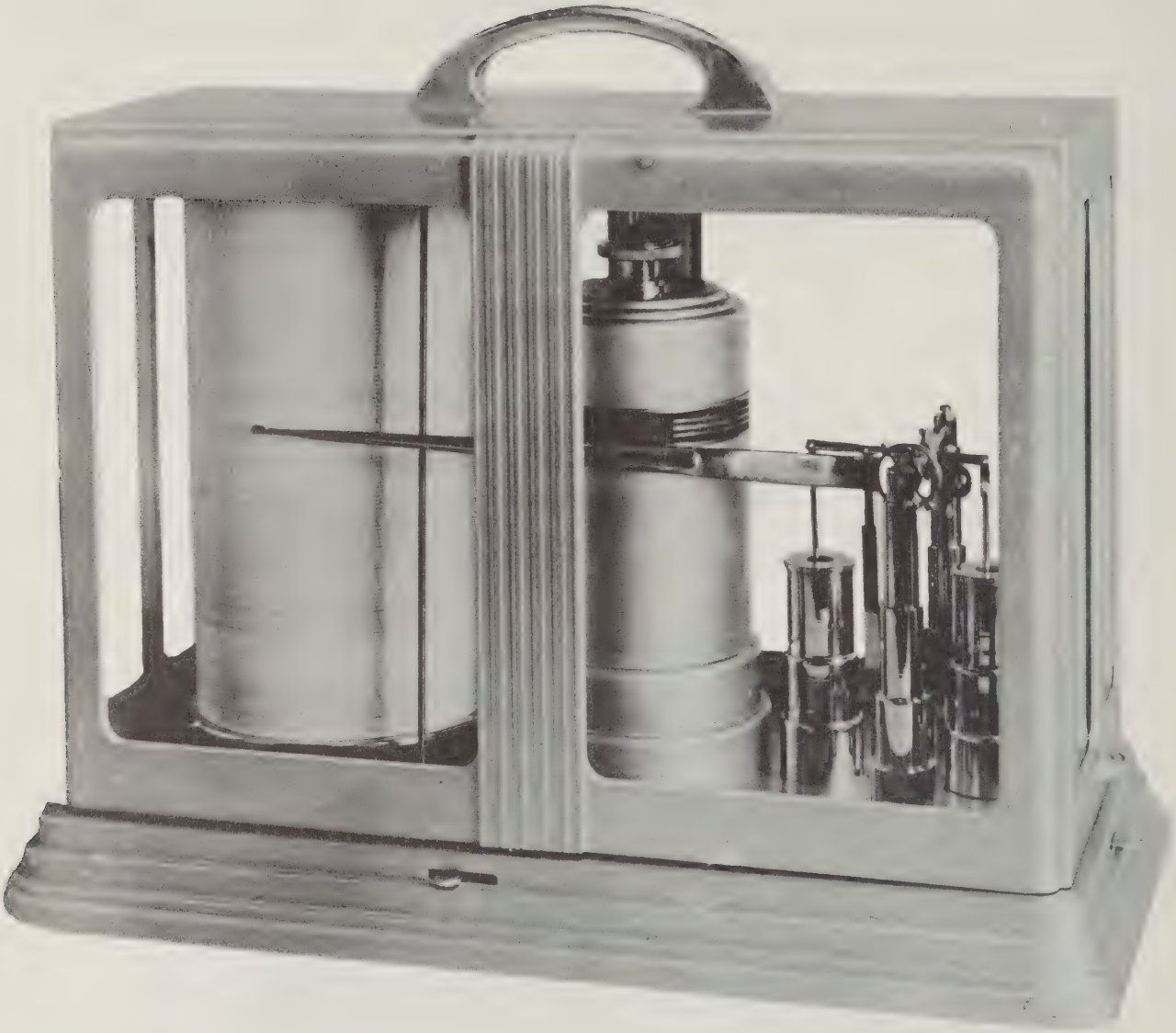


Figure 6-3. Barograph, Marine, W.B. Model G 220.

3.2 Barographs supplied or serviced by the Weather Bureau are adjusted to indicate sea-level pressure on the barogram. Because the barograph is used to obtain the characteristic and three-hour pressure difference and not for sea level pressure readings, adjustments to the barograph to correct it to read current sea-level pressure are not necessary. An exception to this rule occurs when pressure is very high or very low as outlined in ¶3.3. If large discrepancies develop between the

aneroid barometer and the barograph, make a note on the back of ESSA Form 72-1 and the Port Meteorological Officer will calibrate the instruments on his next visit to your ship.

3.3 Extreme Pressure Records. When the pressure changes enough to cause the pen arm to reach the top or bottom of the barogram, the knob at the top of the bellows housing should be turned so as to move the pen point towards the center of the chart. This adjustment should be an amount equal to 30 millibars on the chart scale. Note the time and amount of adjustment in column 40 on ESSA Form 72-1. When the pressure returns to normal, reset the barograph to normal range and note this time and amount of readjustment again on Form 72-1. About 10 minutes after resetting, check the barograph value against the corrected aneroid barometer value to assure an accurate readjustment. When the barogram is removed, mark the time and amount of adjustment at the appropriate points on the record.

3.4 Barogram. Charts placed on the barograph drum to record pressure are called barograms. Weather Bureau barographs are supplied with WB Form 455-12 barogram (Figure 6-4). This is a 4-day chart whose coordinates are millibars and hours. The horizontal lines equal one millibar and vertical lines equal one hour. The heavy horizontal lines are 5- and 10-mb lines.

3.4.1 The barogram should be changed immediately after the 1200 GMT observation every four days.

3.4.2 Entries on the Barogram. Before placing a chart on the barograph, use a typewriter or pen to enter the following data in the spaces provided (see Figure 6-4).

a. Name of ship.

b. Departure port.

c. Destination.

d. Date and time, GMT, the chart is to be put on.

e. The date, GMT, for each day on the chart in the space under "12".

3.4.3 Removing and Installing Barograph Case Covers.

a. On Model G220, raise the pen arm before removing the cover using the lever provided. Unlatch the cover from the base using the lever at the right end. Swing the right end up and over the left (hinged) end.

PRESSURE

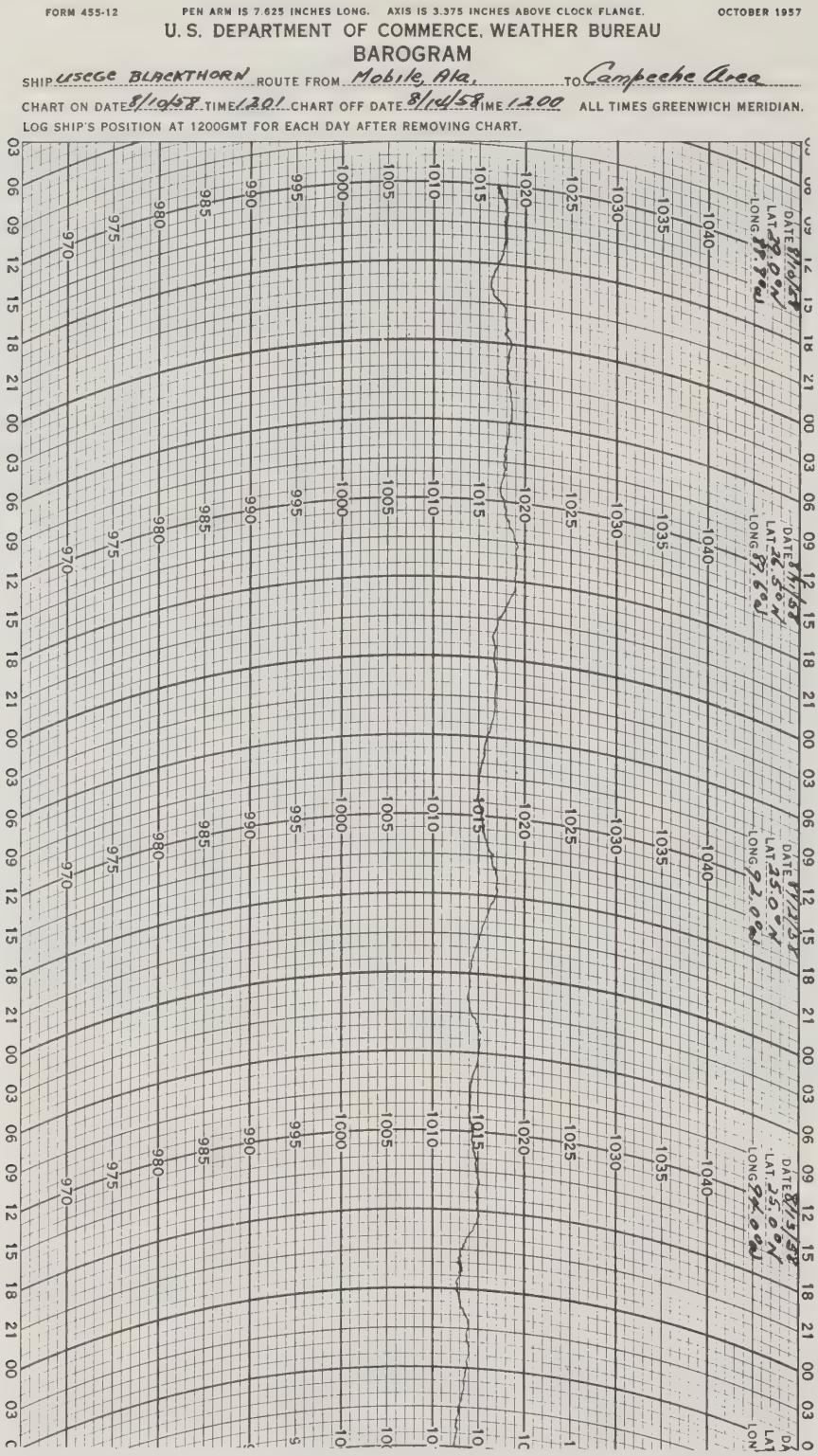


Figure 6-4. Barograph Chart.

b. On Model G222, the pen cannot be raised until the case is opened. The flange on the bottom of the case can catch the pen as the case is being removed and cause damage. Also, static charge may build up on the plastic window, strong enough to pull the pen arm against the window. Wiping the window with a damp cloth will bleed off the charge. Rubbing a small amount of powdered graphite or a few drops of liquid detergent on the window will provide a more lasting effect. Release the catches at each end of the case and lift the case carefully straight up until it clears the instrument. Lift the pen arm away from the chart with the lever provided.

c. Returning the case cover on both models is the reverse of the procedure outlined in a and b above. Lower the pen on Model G222 before replacing the cover and on Model G220 after replacing the cover.

3.4.4 Removal and Installation of Barographs. Charts are removed and installed on most barograph models as follows:

a. After making sure the pen is swung away from the chart, lift the cylinder from the spindle. Be careful not to smear the ink on the graph.

b. Remove the clip bar, and take the barogram off the drum. Lay this chart aside for further entries after the new one is installed. Wind the clock.

c. Wrap the new chart tightly around the drum so that the chart ends meet under the clip bar position.

d. Place the clip bar over the chart end and smooth out any bulges. Slide the clip bar into place when the chart is down against the flange and smooth.

e. Carefully fill the pen with No. 10 barograph ink.

f. Place the cylinder on the barograph and turn it clockwise to the correct time, GMT.

g. Replace the case cover.

h. Enter the date and pen-up time in the "Chart Off" space. Enter the latitude and longitude of the ship at noon, GMT, for each day across the top of the graph.

4. Observing Pressure Tendency.

4.1 Pressure tendency refers to a history of the pressure over a three hour period which includes the amount of change, whether the change was net increase or decrease in pressure and the configuration of the pressure trace on the barogram.

4.2 Reading the Barogram. To observe the pressure tendency from a barograph take the following steps:

a. Make a note of the difference in tenths of a millibar between the current pressure indicated on the barograph and the pressure that was indicated three hours ago. This value will be entered as two figures without the decimal on ESSA Form 72-1 in column 27 unless it is greater than 9.8 mb (see ¶5.2.3).

b. Note the shape of the trace for the past three hours. This will be used to determine the code figure from table 17 in appendix III. When the barograph trace is difficult to classify, follow the procedure outlined in ¶5.2.1.

4.3 Using the Ship's Log and a Barometer. Ships which do not have a barograph may determine the pressure tendency in the following manner:

a. Obtain the pressure three hours ago from the ship's log (interpolating if necessary) and the current pressure from a barometer.

b. Obtain the difference in pressure between now and three hours ago. This value will be entered as two figures without the decimal in column 27 on ESSA Form 72-1 unless the value is greater than 9.8 mb (see ¶5.2.4).

c. The character will be classified as "rising", "falling", or "steady".

5. Encoding and Entering Sea Level Pressure and Pressure Change Data on ESSA Form 72-1.

5.1 Sea Level Pressure (PPP). The symbols PPP in the sixth group of the ship's code stand for sea level pressure in tens, units and tenths of a millibar. The corrected value for pressure in millibars is entered on Form 72-1 in columns 14 and 15. The hundreds value (initial 9 or 10 in the observed value) is entered in column 14 (shaded), and the tens, units and tenths of a millibar are entered in column 15 without the decimal point. E.g., corrected value 1015.2 is entered "10" in column 14 and "152" in column 15.

5.2 Pressure Change Data. Pressure change data are encoded in the eighth group of the ship's code (D_SV_Sapp), represented symbolically by "a" for characteristic and "pp" for amount. These data are entered on ESSA Form 72-1 in columns 26 and 27, respectively.

5.2.1 Characteristic. Use table 17 in appendix III to select the appropriate code figure for entry in column 26. When the barograph trace does not show a clear-cut characteristic try the following techniques:

a. Choose only from code figures which represent the net three-hour pressure change (e.g., if pressure is the same now as three hours ago, consider only code figures 0, 4 or 5).

b. Staying within the group dictated by a, mentally smooth the trace or shorten it, eliminating the oldest portions until the remaining trace fits one of the characteristics represented by the code figures.

5.2.2 Amount of Change (pp). The amount of pressure change over the past three hours in millibars and tenths is entered in column 27 using two figures. The method for obtaining this value is given in ¶4.2a, (or 4.3b if the ship has no barograph). If for some reason the three hour pressure difference is obtained in inches, use table 18 in appendix III to determine the coded value (which is in tenths of millibars).

5.2.3 When the amount of barometric pressure change equals 9.9 millibars or more, pp is encoded "99" and a group of five figures is added in the weather report immediately after D_SV_Sapp. In symbolic form, this group is 99ppp, where 99 is the indicator and ppp is the total 3-hour pressure change in tens, units and tenths of a millibar. If the total pressure change is 13.4 millibars, the 3-hour pressure change is reported as "D_SV_Sa99 99 134". The extra group is entered in column 40 on ESSA Form 72-1 but is placed immediately after the D_SV_Sapp group when transmitted in the weather report. Space has been provided on Form 72-4 in the D_SV_Sapp block to allow entry of two groups in one block.

CHAPTER 7

TEMPERATURE

1. General.

1.1 This chapter deals with the techniques for obtaining the temperatures required in marine meteorological observations. These temperatures are the air temperature, the sea surface temperature, the dewpoint temperature, and the wet-bulb temperature.

1.1.1 In the ship's code, air temperature is reported in the sixth and tenth groups (PPPTT and $1T_WT_WT_Wt_T$) and is represented symbolically by TT for whole degrees and t_T for tenths of a degree.

1.1.2 The dewpoint temperature is reported in the ninth group ($0T_ST_ST_dT_d$) and is represented symbolically by T_dT_d for whole degrees.

1.1.3 The sea surface temperature is reported in the tenth group ($1T_WT_WT_Wt_T$) and is represented symbolically by $T_WT_WT_W$ for tenths of degrees.

1.1.4 The difference between air and sea temperature is reported in the ninth group and is represented symbolically by T_ST_S. Ships reporting on behalf of the U.S.A. will report this value as "//".

1.1.5 The wet-bulb temperature is recorded but is not reported in the ship's code.

1.2 All temperatures are recorded in degrees Celsius. Table 9 in appendix III may be used to convert Fahrenheit to Celsius values. Also, Port Meteorological Officers will supply Celsius scale replacement thermometers.

1.3 The following are definitions of meteorological temperature terminology.

1.3.1 Air Temperature. The temperature measured by an ordinary thermometer exposed to the free air which is not subject to artificial heating or cooling.

1.3.2 Sea Surface Temperature. The temperature of the sea representative of the conditions in the near surface mixed layer underlying the ocean skin. In actual practice, the temperature of a sample of sea water caught in a bucket or measured at the condenser intake.

1.3.3 Psychrometer. A pair of thermometers mounted on a frame with provision for ventilating the thermometer bulbs. The bulb of one thermometer is covered with a muslin sleeve which is dipped in water before use while the bulb of the other is bare. The thermometers are referred to as the "wet-bulb" (covered) and the "dry-bulb" (bare).

1.3.4 Dry-Bulb Temperature. Air temperature (See ¶1.3.1).

1.3.5 Wet-Bulb Temperature. The lowest obtainable temperature of the wet-bulb thermometer in a psychrometer which has been ventilated.

1.3.6 Depression. The algebraic difference between the dry-bulb and the wet-bulb temperatures. The amount that the temperature is depressed by evaporating water from muslin on the thermometer bulb.

1.3.7 Dewpoint Temperature. A computed temperature which represents the point at which condensation would occur if the air were cooled without adding or subtracting moisture. This is the temperature at which dew should form.

2. Observing Temperature.

2.1 Air Temperature Exposure. Thermometers should be exposed on the windward side of the ship, away from bulkheads and vents. Sunlight falling on the thermometer will expand the thermometer materials, causing artificially high readings. The observer should stand downwind from the thermometer and far enough away to keep body heat from affecting the reading.

2.2 Reading Air Temperature Thermometers. Locate the top of the liquid column within the thermometer and adjust the line of sight so that it makes an angle of 90° with the thermometer tube at the top of the liquid. Read the scale, estimating to the nearest tenth of a degree between scale markings.

2.3 Using Psychrometers. The two types of psychrometers in use for Weather Bureau marine observations are the Sling Psychrometer (Figure 7-1) and the Electric Aspirated Psychrometer (Figure 7-2). When either type is available, the dry-bulb thermometer reading shall be used as the air temperature.

2.3.1 When the difference between indoor and outdoor temperature is greater than about 5°C or 10°F, the psychrometer should be brought outdoors at least 10 minutes before use. If possible the instruments should be stowed outside in a protected space.

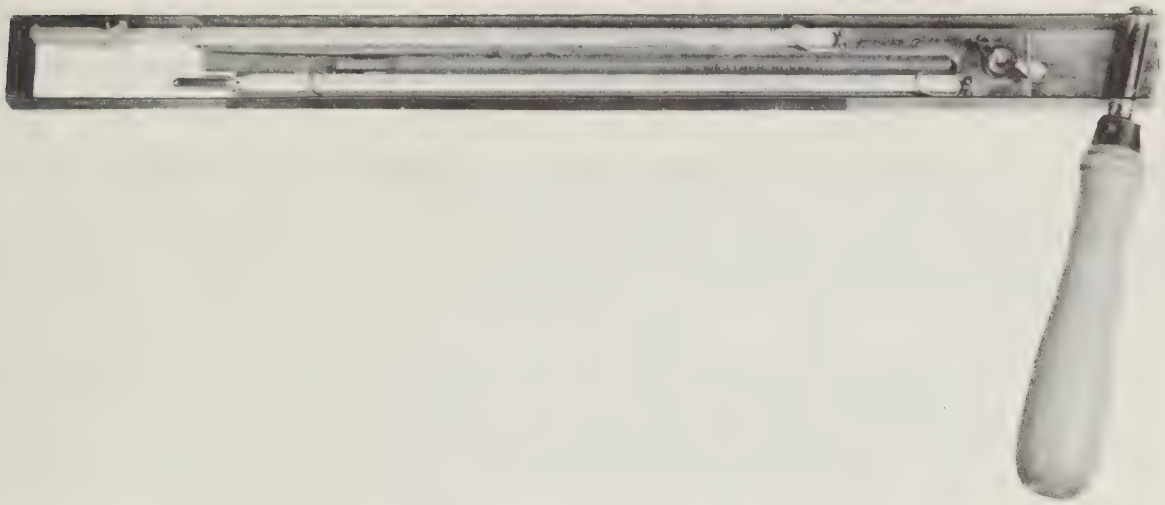


Figure 7-1. Sling Psychrometer.

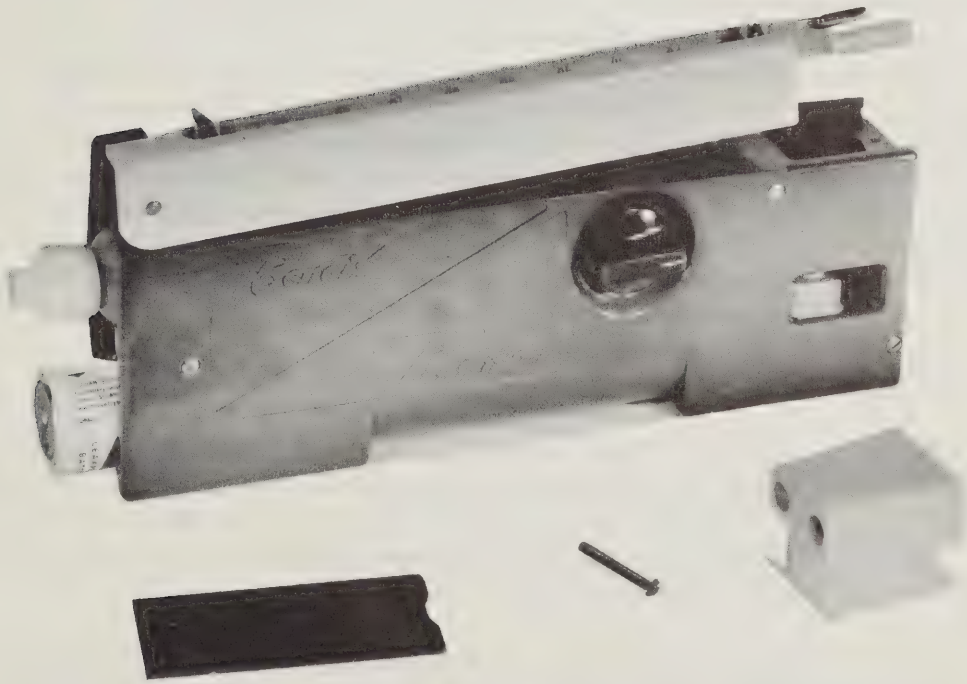


Figure 7-2. Psychrometer (Portable, Aspirated, Electric).

2.3.2 Use distilled water or condenser water stored at room temperature to moisten the wet-bulb muslin. Be careful not to moisten the dry-bulb.

2.3.3 After moistening, ventilate the psychrometer at the exposure site for about 10 seconds and then read the wet-bulb thermometer. Repeat this process until the wet bulb temperature stabilizes at the lowest value. Then read and record the wet-bulb and dry-bulb temperatures to tenths of degrees.

a. The sling psychrometer is ventilated by holding it firmly at arms length and whirling it at a rate of about 4 revolutions per second (9 knots or 15 feet per second). Whirling is unnecessary when the apparent wind speed is 9 knots or more.

b. The electric psychrometer is ventilated by turning it on under all wind conditions. The plastic shield over the two thermometer bulbs must be in place with the wide opening facing away from the thermometers for proper ventilation.

2.3.4 Special Procedures For Wet-Bulb Temperatures Below Freezing. Tables for determining dewpoint are based on the assumption that wet-bulb thermometers with temperatures below freezing (0°C or 32°F) have a thin coating of ice on the muslin. Therefore, a thin coating of ice must form on the wet-bulb when the wet-bulb temperature falls below freezing. When the ice is formed naturally, the wet-bulb temperature will fall steadily to 0°C then pause momentarily while the water freezes. Then the temperature will begin to fall again until the lowest wet-bulb temperature is attained. If the wet-bulb temperature falls steadily without a pause at 0°C, ice probably did not form. Freezing can be induced by touching the muslin to a cold exposed object, or touching a piece of ice to the muslin. After freezing is induced, resume ventilation as specified in ¶2.3.3.

2.4 Sea Water Thermometers.

2.4.1 The sea water intake thermometer is used on most merchant vessels for obtaining sea surface temperature. Where other systems are available, such as a bucket sample, or remote readout direct sensing devices, the Port Meteorological Officer will recommend procedures tailored to the equipment available.

2.4.2 Intake thermometers vary in scale markings. It is recommended that the thermometer scale be read to the nearest tenth of the scale values, e.g., if the scale is marked for each 2° estimate values to the nearest 0.2°.

2.4.3 The reading for sea surface temperature should be made within 15 minutes of the scheduled observation time. Fahrenheit values are converted to tenths of a degree Celsius, using table 9 in appendix III.

3. Maintaining Thermometers at Sea.

3.1 Thermometers should be kept free of foreign matter. Whenever salt spray comes in contact with the wet-bulb muslin install new muslin. The wet-bulb muslin should be replaced once a week or more often whenever it becomes soiled or encrusted with lime. Use of the purest water available will minimize cleaning of the thermometer bulbs. If the mercury column in a thermometer becomes separated, replace it with a spare thermometer and return the defective one to the Port Meteorological Officer.

4. Computing the dewpoint temperature from psychrometric readings.

4.1 The depression (difference between the dry-bulb and the wet-bulb temperatures) and the wet-bulb temperature are used to determine the dewpoint temperature. Obtain the depression in the following manner:

a. If the wet-bulb temperature has the same algebraic sign as the dry-bulb temperature i.e., both above zero or both below zero, subtract the small number from the large number without regard to the algebraic sign.

b. When the wet-bulb temperature is below zero and the dry-bulb temperature is above zero, ignore the algebraic sign of the wet-bulb temperature and add the two values to get the depression.

Examples:

1.	Dry-bulb temperature----------	+1.4	(add)
	Wet-bulb temperature----------	-0.3	
	Depression----------	1.7	
2.	Dry-bulb temperature----------	13.5	
	Wet-bulb temperature----------	9.3	(Subtract)
	Depression----------	4.2	
3.	Dry-bulb temperature----------	-1.3	
	Wet-bulb temperature----------	-2.8	(subtract dry from wet)
	Depression----------	1.5	

4. Dry-bulb temperature---------- 13.5
Wet-bulb temperature---------- 13.5
Depression---------- 0
Dewpoint temperature---------- 14

Note: In rare instances when the air temperature is below freezing, the wet-bulb temperature may remain higher than the dry-bulb temperature after ventilation. The observer should recheck the readings and log the values as read and add a note, "wet-bulb rechecked" in column 40 of ESSA Form 72-1. The dewpoint temperature is obtained in this case by using the dry-bulb temperature as the wet-bulb temperature with depression = 0.

4.2 To find the dewpoint temperature use table 24 in appendix III. Read the dewpoint temperature at the intersection of the "depression" column and "wet-bulb temp" row. All dewpoint temperature values in this table are encoded for T_dT_d in the ship's code and should be entered on ESSA Form 72-1 as read. (When other tables are used for the dewpoint temperature, negative values are to be encoded by dropping the minus sign and adding 50 to the numerical value, and dewpoint temperatures of 0° to and including 9° should be preceded by a zero when entered.)

5. Encoding and Entering Temperature Data on ESSA Form 72-1.

5.1 Negative Air or Sea Temperature. The minus sign is not used in the ship's code. Therefore, to indicate negative temperature values, add 50.0 to the absolute value, drop the minus sign and record the result in the appropriate column.

5.2 Air Temperature (TT and t_T). Whole degrees of air temperature are entered in column 16 using two figures. Tenths of a degree of air temperature are entered in column 17 and are repeated in the coded portion in column 33.

5.2.1 If, for some reason, the sea surface temperature cannot be obtained, use the following special procedure for entering air temperature:

a. Log the air temperature in tenths of degrees in column 40, preceded by an asterisk (*).

b. Omit the $1T_WT_WT_Wt_T$ group (columns 31, 32 and 33) from the weather report.

c. Enter the air temperature rounded off to the nearest whole degree in column 16.

d. Place another asterisk (*) in column 17.

5.3 Wet-Bulb Temperature. Enter the wet-bulb temperature to tenths of a degree in column 18.

5.4 Air-Sea Temperature Difference (T_sT_s). Merchant ships reporting on behalf of the U.S.A. need not compute this value. Transmit "//" as printed in the column.

5.5 Dewpoint Temperature (T_dT_d). Enter the coded dewpoint temperature value in column 30. When this value is not obtained for any reason, omit the entire $OT_sT_sT_dT_d$ group from the weather report.

5.6 Sea Surface Temperature ($T_wT_wT_w$). Enter the sea surface temperature to tenths of a degree without the decimal. Use three figures. See ¶5.2.1 for procedures when the sea surface temperature is not reported.

5.7 Tenths of Air Temperature (t_T). (See ¶5.2.) Copy the value entered in column 17 in column 33.

CHAPTER 8

CLOUDS

1. General.

1.1 Cloud data are reported in the fourth and seventh groups of the ship's code (Nddff and $N_hC_LhC_MC_H$). This chapter discusses the observation and reporting of total sky cover (N), low or middle cloud sky cover (N_h), height of the base of the lowest cloud (h), low clouds (C_L), middle clouds (C_M) and high clouds (C_H).

1.2 The term "low clouds" refers to the group of clouds of the genera stratus, stratocumulus, cumulus and cumulonimbus. The term "lowest cloud" refers to a cloud or group of clouds whose base is lower than all of the other clouds present. "Middle clouds" refers to clouds of the genera nimbostratus, altostratus and altocumulus. "High clouds" refers to clouds of the genera cirrus, cirrostratus and cirrocumulus.

2. Determination of Sky Cover.

2.1 "Sky cover" is a term used to denote the amount, in eighths, of sky covered by clouds. The eighths of sky covered plus the eighths of sky visible will always equal 8/8. Two values are required. One for the "Total Sky Cover" and one representing only the low or middle cloud cover.

2.2 When estimating sky cover it is helpful to divide the sky into quadrants with the center overhead, and estimate the sky cover quadrant by quadrant, with each quadrant containing 2/8 of the sky. Regard the sky as being divided into two parts by a line fore and aft across the sky passing over the length of the ship, with the port and starboard halves each divided in half by another line port to starboard across the sky passing over the beam of the ship.

2.2.1 Estimate the sky cover in each quadrant and add together the amounts in each quadrant. This is the total sky cover.

2.3 Total low cloud (C_L) or total middle cloud (C_M) cover.

2.3.1 When a low cloud type is present, determine the sky cover of all low clouds (C_L), using the above procedures, but ignoring amounts of middle and high clouds (C_M and C_H).

2.3.2 When no low cloud is present, but middle clouds are, determine the sky cover of all middle clouds (C_M), ignoring high cloud types (C_H).

2.3.3 When there is no low or middle cloud present, the second value is zero.

2.3.4 Example: If a continuous middle cloud layer covers the sky from the forward horizon to overhead (covering two quadrants) and scattered low clouds cover one half of each after quadrant, the total sky cover is 2/8+2/8+1/8+1/8=6/8. The second value representing only the sky covered by low cloud types (see ¶2.3.1) is 1/8+1/8=2/8.

2.4 Obscured Sky. When the sky is completely hidden (neither clouds nor clear sky can be seen) due to the weather at the surface (fog, haze, smoke or dense precipitation such as snow, heavy rain, moderate or heavy drizzle) the sky is "obscured". This term applies only when all of the sky is hidden.

2.4.1 When the sky is only partially hidden by surface based phenomena i.e., stars, clear sky or cloud covering can be seen and identified through thin spots or openings in the phenomena, judge the total sky cover as if the whole sky were in the same condition as that part which can be seen.

3. Estimating the Height of the Lowest Cloud Base.

3.1 General. Cloud classification is based upon both the cloud structure and the height at which the cloud type normally appears. The observer should first determine the type of the lowest cloud and refer to Table 8-1 below which gives the normal height range of cloud types in the temperate zones. These heights will be higher in the tropics and lower in high latitudes. Similarly, heights will be higher in summer and lower in winter.

Table 8-1

Normal Heights of Cloud Types in Temperate Zones

Cloud Type	Normal Height	Code Figure Choices
All High Clouds (C_H)	17,000 - 45,000 ft.	9
Middle Clouds (C_M)		
Altocumulus	6,500 - 23,000 ft.	8, 9
Altostratus	6,500 - 23,000 ft.	8, 9
Nimbostratus	500 - 2,000 ft.	2, 3, 4, 5
Low Clouds (C_L)		
Stratocumulus	1,500 - 4,500 ft.	4, 5, 6
Stratus	0 - 1,500 ft.	0, 1, 2, 3, 4
Cumulus, Cumulonimbus	1,500 - 5,000 ft.	4, 5, 6, 7

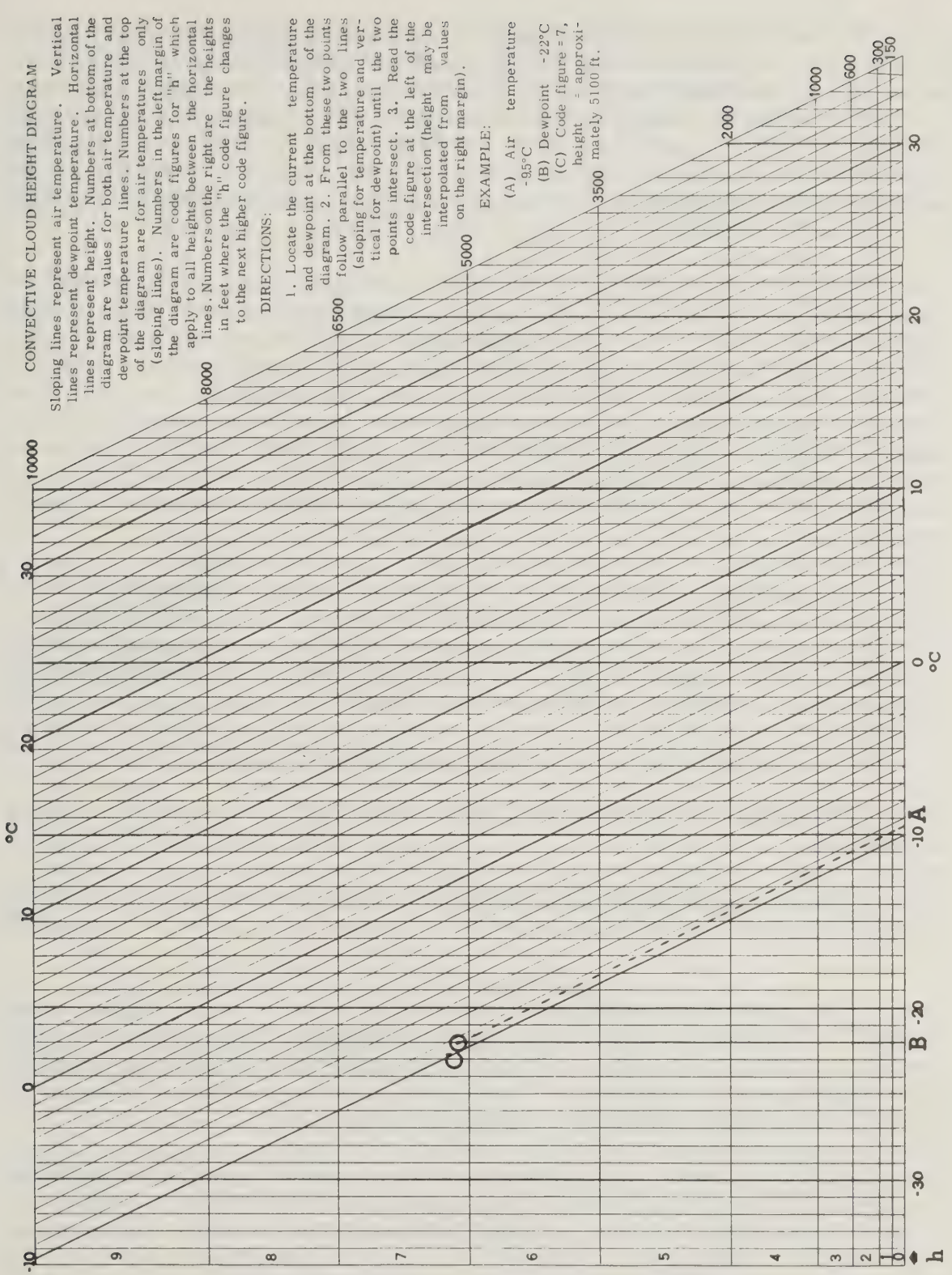


Figure 8-1. Convective Cloud Height Diagram.

3.2 The height of cumuliform cloud bases can be approximated by using a mathematical relationship between the air temperature and the dewpoint. The diagram in figure 8-1 is based upon this relationship and can be used to obtain a code figure, or height of cloud base, when the cloud type is cumulus, cumulonimbus or altocumulus. Also, the height of stratocumulus bases can be obtained using the diagram when the air is turbulent, as evidenced by strong, gusty surface winds. Instructions are printed on the diagram.

3.3 When recourse has to be made to a pure estimate, the first step is to identify the cloud type and refer to the normal height range of that cloud type in table 8-1. The appearance of the cloud, such as motion visible in the cloud base and the size of cloud elements, gives some indication as to how much it is higher or lower than average. For very low clouds, a rough idea of the height can be obtained by comparing the apparent speed of movement with the surface wind. When the cloud appears to move rapidly with light or moderate surface winds, it is near the surface while slow movement with strong surface winds indicates a higher base.

3.4 Skill in height estimates can be obtained by making practice estimates on cumuliform clouds using the convective cloud height diagram as a check. In port, the Port Meteorological Officer or the local weather office can check practice estimates. Phone numbers and addresses of Weather Bureau offices are found in appendix II.

4. Encoding and Entering Cloud Data on ESSA Form 72-1.

4.1 Cloud data are entered on ESSA Form 72-1 in columns 8, and 19 through 23.

4.2 Total Cloud Amount (N). Select a figure from table 3 in appendix III which represents the eighths of total sky cover and enter it in column 8.

4.3 Total Low or Middle Cloud Amount (N_h). Select a code figure from table 10 in appendix III which represents the eighths of sky covered by all low (C_L) clouds (or if no C_L cloud is present by all middle C_M clouds). Enter this figure in column 19. This figure must be less than or equal to the "N" code figure selected for entry in column 8.

4.4 Height of Lowest Cloud Seen (h). Select a code figure from table 12 in appendix III which represents the height of the base of the lowest cloud in sight. Enter this figure in column 21. Note: If the lowest cloud present is based above 8000 feet, or the sky is clear, the code figure will be "9", and if the sky is completely obscured, the code figure will be "/" (see ¶5).

4.5 Low Clouds (C_L). Select the code figure for the type of low cloud present from table 11 in appendix III, the cloud chart in each pad of Form 72-1, the Marine Cloud Album or the International Cloud Atlas, and enter this figure in column 20. When more than one type of low cloud is present, use the following procedures:

a. The following C_L code figures are listed in their order of priority, regardless of amount.

9 cumulonimbus capillatus
3 cumulonimbus calvus
4 stratocumulus cumulogenitus
8 cumulus and stratocumulus at different levels
2 cumulus congestus

b. When cloud types 9, 3, 4, 8 or 2 are not present, code figure 1, 5, 6, or 7 may apply. All of these code figures have equal priority except that the type present which covers the greatest amount of sky will be selected as predominant. When there is a choice between two predominant types because they cover equal amounts of sky, report the type with the highest base.

4.6 Middle Clouds (C_M). Select a code figure for the type of middle cloud present from table 13 in appendix III (or other source, see ¶4.5) and enter this figure in column 22. If more than one middle cloud type is present, select the highest applicable code figure except that code figures 2 and 1 take precedence over code figures 7, 6, 5, 4 and 3.

4.7 High Clouds (C_H). Select a code figure for the type of high cloud present from table 14 in appendix III (or other source, see ¶4.5) and enter this figure in column 23. If more than one high cloud type is present, select the code figure for the type which covers the greatest amount of sky.

5. "Clear" or "Obscured" Sky Reports.

5.1 When the sky is absolutely cloudless, the code group which is entered in columns 19 to 23 and transmitted shall be "00900".

5.2 When the sky is completely obscured by surface based phenomena, the code group which is entered in columns 19 to 23 and transmitted shall be "9////".

CHAPTER 9

WAVES

1. General.

1.1 Wave data are reported in one or more groups in the ship's code when waves are observed. Wind waves are encoded in the form $3P_wP_wH_wH_w$, and swell is encoded in the form $d_wd_wP_wH_wH_w$ which may be repeated for each observed swell pattern. Swell is not reported when the swell direction does not differ from the wind direction by 30° or more. Similarly, additional swell groups need not be encoded unless their direction differs from both the wind and dominant swell pattern report by 30° or more. The wave observation includes determining the period and height of wind waves and the direction, period and height of swell.

1.2 Definitions.

1.2.1 Wind Waves. The system of waves raised by the local wind at the time of observation. Also referred to as "SEA".

1.2.2 Swell. Those waves not raised by the local wind, but rather by distant wind systems or by winds that have ceased to blow.

1.2.3 Swell Direction. The direction (true) in tens of degrees from which the swell is coming. Note: Since wind wave direction is assumed to be the same as the wind direction, no provision is made in the code to report wind wave direction.

1.2.4 Period. The interval in seconds between the passage of two successive crests of well-formed waves past a fixed point.

1.2.5 Wave Height. The vertical distance between a crest and the troughs on either side of it.

2. Observing Guidelines.

2.1 It is recognized that ships' officers who are assigned to take weather observations cannot leave the bridge to move about the ship and gather wave observation data, nor can they spend long periods timing wave trains. These officers can develop skill in observing wave data from the bridge by observing the data in the locations recommended in the following instructions just before going on duty and then comparing the sea's appearance from the bridge. The process of timing wave trains can be shortened with experience so that the observer need only time a few representative wave "sets" to derive the period. During the wave observation, use a note pad to record direction, period and height for each pattern observed.

2.1.1 Waves in the same system usually occur in a sequence of a few large, well formed waves followed by an interval in which only small and poorly formed waves occur, then another series of well formed waves etc. (see fig. 9-1). Observers should determine the required values using only the well formed waves and ignoring poorly formed waves.

Figure 9-1. Well-Formed Waves (A) Shown on Automatic Wave Recorder Trace

2.2 Wave Period. To determine the period of wind waves or swell, select a distinctive patch of foam or a small floating object at some distance from the ship. As the object falls astern select a new one. Note the elapsed time to the nearest second between the moments when the object is on the crest of the first and of the last well formed wave in the group. Also note the number of crests that pass under the object during the interval. Continue the observation until at least 15 waves have been timed. Add the elapsed times of the various groups together and divide the total by the number of waves to obtain the average period.

2.3 Wave Height. The wave height should be estimated from the best available point on the ship that permits the height of the waves to be compared to the height of the ship. The point of observation should be chosen amidships, where the pitching of the vessel is at a minimum. The wave height should be estimated when the ship is on an even keel. In general, it has been found by comparing instrument measurements to eyeball estimates, that small wave heights are underestimated while large wave heights are overestimated. Theoretically, the wave height cannot exceed 1/13 of the wave length, measured from trough to trough.

2.3.1 To compare wave height with the heights of known objects:

a. Look over the side and compare the height of waves with known points on the side of the ship.

b. When in a trough of a wave, move up and down on the side of the ship until the wave crests appear momentarily on a horizontal plane with the eye. The wave height is then equal to eye-level height above the waterline.

c. When in company with another ship and your ship is on an even keel, the height from trough to crest of a wave against the other ship's side can be estimated as a part of some known vertical distance. For example, a wave height may be 1/4 of the other ship's bridge height of 28 feet, or seven feet high.

2.4 When both sea and swell, or two systems of swell, are present at the same time, estimate the higher system of waves first, then repeat the process for the lower system.

2.5 Swell Direction. Swell direction may be determined by "eyeball" or by sighting from a compass along wave crests and adding or subtracting 90°. Ship's true heading can also be used to determine the direction from which swells are approaching. The higher the observation point, the easier it is to determine swell direction. The average of several observations should be used as the reported swell direction. Directions should be observed to the nearest ten degrees.

3. Encoding and Entering Wave Data on ESSA Form 72-1.

3.1 Wave Data Columns. Wave data are entered in columns 34 thru 39. The first group, columns 34-36, must be included in the message except as specified in ¶3.5. When there are no wind waves but swell is observed, the first group is encoded "30000". The second group, columns 35-39, is included only when swell is observed. Add as many swell groups as necessary to report the sea condition. Enter additional swell groups in the lower half of columns 35-39 and in column 40 in their descending order of importance.

3.2 Wind Wave and Swell Heights (H_WH_W). Use code table 17 in appendix III to convert the heights for wind waves and swell in feet to the code figure for columns 36 and 39 respectively. The code is based on wave heights estimated to the nearest half meter. For example, a height of 7 meters is reported using code figure 14, i.e., 14 half meters.

3.2.1 When the height is not reported for any reason, two slants (//) are entered in columns 36 and 39.

3.3 Period of Waves (P_WP_W and P_W). The period code is different for wind waves (P_WP_W in column 35) and swell (P_W in column 38).

3.3.1 Wind Wave Period (P_WP_W).

a. The entry in column 35 is the average period in seconds using two figures. For example; a period of 6 seconds is entered 06; 13 seconds is entered 13; and calm is entered 00.

b. When the wind wave period cannot be determined because the sea is confused, enter "99" in column 35.

c. When the wind wave period cannot be determined for any other reason, enter two slants (//) in column 35.

3.3.2 Swell period (P_w). The code figure for swell period is entered in column 38. Select a figure from code table 26 in appendix III.

3.4 Swell Direction ($d_w d_w$). The direction of swell is entered in column 37. This is the direction from which the swell is coming in tens of degrees, using "01 - 36" for directions 010° to 360°, "00" for calm, and "99" for a confused sea with direction indeterminate. If the swell direction is determined to the nearest degree, convert the value to the nearest 10 degrees and drop the final zero. The code figure for swell direction may be obtained in table 25 in appendix III, or the observed direction may be rounded off to the correct code figure as in the examples below.

True Direction Nearest Degree	Rounded Value	Code Figure
315	320	32
314	310	31
4	360	36
5	10	01
93	90	09
95	100	10
Calm	000	00

3.5 Omission of Wave Data. Both groups will be omitted when the sea condition is not observed for any reason. The wind wave group will be encoded under all other circumstances and:

a. The swell group will be omitted when wind waves are reported as confused, i.e. 399//.

b. The swell group will be omitted when the swell direction is not classified as confused and a direction cannot otherwise be determined.

c. The swell group will be omitted when the sea is calm. The wind wave group in this case will be encoded "30000".

CHAPTER 10

ICE

1. General.

1.1 This chapter contains instructions for encoding icing on the ship's superstructure and sea ice for inclusion in the ship's code. The two groups, Ice Accretion ($2I_SE_SE_SR_S$) and sea ice (Ice C_2KD_ire), are added to the ship's code when observed.

1.2 Section 2 contains all instructions for encoding ice accretion and sections 3 and 4 contain definitions and encoding instructions for sea ice.

2. Encoding and Entering Ice Accretion Data on ESSA Form 72-1.

2.1 The International Convention for the Safety of Life at Sea requires vessels to furnish reports of ice accretion on the ship's superstructure. Ice accretion is entered on Form 72-1 in column 40. For transmission, the group is placed after the $1T_WT_WT_WtT$ group and ahead of the $3P_WP_WH_WH_W$ group. Form 72-1 contains space for this group in its proper order (see figure 1-2).

2.1.1 Group Indicator (2). The figure 2 identifies the ice accretion group.

2.1.2 Source of Ice Accretion on Ship (I_S). Select the code figure from table 20 in appendix III which represents the source of the ice forming or melting on the superstructure.

2.1.3 Thickness (E_SE_S). At each scheduled observation measure the thickness of the ice on an exposed object where the ice buildup is greatest. If possible, use a centimeter stick to measure the thickness. Otherwise, measure the thickness in inches and refer to table 21 in appendix III or convert the value to centimeters. A rough conversion of 0.4 in. = 1 cm may be used for convenience. Enter the value in cm, using two figures, as the third and fourth figures in the group. Use "00" for less than 1 cm (0.4 in.).

2.1.4 Rate of Ice Accretion on Ship (R_S). The rate of ice accretion is encoded as the final figure in the group. Select a code figure from table 22 in appendix III which indicates the trend of the icing.

2.5 Example:

A typical ice accretion group might be "22041". Decoded, this would be: 2, ice accretion data; 2, icing from fog; 04, ice approximately 4 cm thick where accumulation is greatest; 1, ice building up slowly.

3. Identification of Sea Ice.

3.1 General. The presence of ice at sea, including icebergs, is recorded as part of the ship's code on Form 72-1 when ice is visible, or has been observed at a point within a distance of 30 miles from the ship's position at the time of the weather observation.

3.2 Reporting icebergs or sea ice in the weather report serves meteorological purposes only. Iceberg and sea ice reports required by the International Convention for the Safety of Live at Sea, and upon request, by the U.S. Naval Oceanographic Office and the U.S. Coast Guard should be submitted separately to the appropriate address.

3.3 Ice Observation. The ice observation includes determination of the kind of ice, the effect of the ice on navigation, the bearing of the ice-limit, the distance to the ice-limit and the orientation of the ice-limit.

3.4 Kind of Ice. Ice is observed in terms of the most important or prominent of the following conditions:

3.4.1 Ice-blink. Ice-blink is the whitish glare on low clouds above an accumulation of distant ice. The sea ice causing the "blink" is beyond the range of vision. When observed, determine the bearing of the ice-blink.

3.4.2 New-Ice. A general term which includes the following types:

a. Frazil Ice. Fine spicules or plates of ice suspended in water.

b. Grease Ice. A later stage of freezing than Frazil ice when the crystals have coagulated to form a soupy layer, giving a dull appearance to the sea surface.

c. Slush. Snow which is saturated and mixed with water as a viscous floating mass in water after a heavy snowfall.

d. Pancake Ice. Circular pieces of ice ranging from 1 to 10 feet in diameter, with raised rims due to the pieces striking against each other.

e. Ice Rind. A brittle shiny crust of ice formed on a quiet surface by direct freezing or from grease ice, usually in water of low salinity. Ice rind thickness ranges up to two inches. It is easily broken into rectangular pieces by wind or swell and makes a tinkling noise when passed through by a ship.

3.4.3 Fast Ice. Sea ice which forms and remains fast along the coast, where it is attached to the shore, or other ice attached to the shore. Vertical fluctuations may be observed when the sea height changes. Fast ice may also be found over shoals, held in place by islands, grounded icebergs or grounded polar ice.

3.4.4 Pack Ice. Term used to include any area of sea-ice, other than fast-ice, no matter what form it takes.

3.4.5 Packed Slush or packed strips of hummocked-ice. This condition involves pack ice made compact by wind, swell or current. When hummocked-ice is run together in this manner to form a long narow area of pack-ice about 1/2 nautical mile, or less, wide, it is also termed a "strip."

3.4.6 Shore Leads. A fracture or passageway between fast ice or pack ice and the shore. The term applies even if the lead is covered with new ice.

3.4.7 Hummocked Ice. This term refers to pieces of ice piled one on top of the other to form an uneven surface. When weathered, hummocked ice has the appearance of smooth hillocks.

3.4.8 Icebergs. A large mass of floating or stranded ice, greatly varying in shape, extending more than 15 feet above the sea surface, which has broken away from a glacier. Icebergs may be described as "tabular" (flat on top), "dome shaped," "sloping," "pinnacled," "weathered" or "glacier bergs" (irregularly shaped).

3.5 Bearing, Distance and Orientation. When ice is in sight, estimate the distance to the nearest part of the ice (ice limit) and determine the true bearing to 8 points of the compass. When a definite edge can be seen, determine the orientation of the nearest edge, i.e., whether the edge line lies NE-SW, E-W etc. When ice blink is the only ice present, the distance is reported as "unspecified" and the bearing is the bearing of the blink.

4. Encoding and Entering of Ice Data on ESSA Form 72-1.

4.1 General. Ice observed at sea is coded and entered on Form 72-1 in column 40. The word "ICE" is entered, followed by the code group "c_2KD_i re" or plain language. The code elements are discussed below. If plain language is used, the data should follow the same order as the elements discussed below.

4.1.1 Ice Indicator that sea ice data follows.

4.1.2 Kind (c_2). Select the code figure from table 27 in appendix III which represents the dominant kind of ice observed, and enter the figure in column 40 as the first figure in a five-figure group following ICE. Note that different code figures apply for Fast Ice and Heavy Fast Ice and for Pack Ice and Heavy Pack Ice. "Heavy" applies to the concentration of ice, not the thickness.

4.1.3 Effect on Navigation (K). Select the code figure from table 28 in appendix III which represents the effect of the ice on navigation, and enter it as the second figure in the ICE group.

4.1.4 Bearing of Ice-Limit (D_i). Select the code figure from table 29 in appendix III for the bearing of the nearest part of the ice, and enter it as the third figure in the ICE group:

a. If an ice-blink was recorded under "Kind" (c_2), report the bearing of the blink.

b. When more than one area of ice is observed, record code figure "9" except as in c. below.

c. When more than one area of ice is observed and one of the areas is of outstanding importance to navigation, the bearing of the ice-limit for that area only will be reported.

4.1.5 Distance to Ice-Limit from Reporting Ship (r). Select the code figure from table 30 in appendix III for the distance from the ship to the edge of the ice (bearing given as D_i), and enter the figure as the fourth figure in the ICE group.

4.1.6 Orientation of Ice-Limit (e). Select the code figure from table 31 in appendix III for the orientation of the edge of the ice (the same edge as reported in D_i and r), and enter it as the fifth and final figure in the ICE group.

4.1.7 Reporting Icebergs. Icebergs may be reported using the ice group or plain language. If only one berg is seen at the time of observation (for example, to the northwest at a distance of 5 miles), the ice group would be encoded ICE 90730. If several icebergs are sighted in various directions and distances, the ice group may be used to report sea ice, if any, and the icebergs may be reported in plain language at the end of the ice group (see example, section 5). If only icebergs are seen, they may be reported in plain language, e.g., ICE 4 BERGS.

5. Example, Sea Ice Report. The coded group "ICE 10423 4 BERGS" is decoded as follows:

ICE Group Indicator

1 New ice present
0 Navigation unobstructed
4 Ice-limit toward south
2 Ice-limit 2 to 4 miles away (south)
3 Ice-limit lying in a direction SE to NW with the ice situated to the NE
4 BERGS - Four icebergs sighted within 30 n. mi. of ship's present location.

APPENDIX II

ADDRESSES OF WEATHER BUREAU MARINE CENTERS* AND PORT OFFICES

ESSA, Weather Bureau Marine Centers have personnel who visit ships in port to check and calibrate barometers and other meteorological instruments. In addition port meteorologists assist masters and mates with problems regarding weather observations, preparation of weather maps, and forecasts. Meteorological manuals, forms, and some instruments are also provided.

ATLANTIC AREA

Weather Bureau Office*
30 Rockefeller Plaza
New York, N.Y. 10020
971-5561

Weather Bureau Office
U.S. Coast Guard Base
427 Commercial Street
Boston, Mass. 02109
CA 7-8139

Weather Bureau Office
U.S. Customhouse, Rm.G-6
101 E. Main Street
Norfolk, Va. 23510
MA 2-5705

GULF AREA

Weather Bureau Office*
701 Loyola Avenue
New Orleans, La. 70113
525-4064

Weather Bureau Office
146 Federal Building
Mobile, Ala. 36602
433-3241

Weather Bureau Office
1002 Federal Office Bldg.
Houston, Texas 77014
228-4265

GREAT LAKES AREA

Port Meteorological Officer
Marine Services Unit
Weather Bureau Airport Station
Cleveland Hopkins International Airport
Cleveland, Ohio 44135
267-3900

PACIFIC AREA

Weather Bureau Office
2544 Custom House
300 South Ferry Street
Terminal Island
San Pedro, Calif. 90731
831-9281 ext. 239

Weather Bureau Airport Station
Lindbergh Municipal Airport
San Diego, California 92101
293-5609

Weather Bureau Office*
Rm. 219A, Custom House
San Francisco, Calif. 94111
556-2490

Weather Bureau Office
Box 3650, Pier 2
Honolulu, Hawaii 96811
588-869

Weather Bureau Office
703 Federal Building
Seattle, Wash. 98104
583-5447

APPENDIX II

OTHER WEATHER BUREAU FACILITIES

The following ESSA, Weather Bureau Offices will provide forecasts and climatological data or arrange to obtain these services from other offices. These offices will also check your barometer in their office or by telephone.

ATLANTIC AREA

Weather Bureau Airport Station
Portland City Airport
Portland, Maine 04102
775-3235

Weather Bureau Airport Station
T.F. Green Airport
Hillsgrove, Rhode Island 02886
RE 7-5100

Weather Bureau Airport Station
Bridgeport Municipal Airport
Stratford, Connecticut 06497
DR 8-2344

Weather Bureau Airport Station
Terminal Bldg., International Airport
Philadelphia, Pennsylvania 19153
SA 6-4275

Weather Bureau Airport Station
Friendship International Airport
Baltimore, Maryland 21240
SO 6-2434

Weather Bureau Airport Station
Norfolk Municipal Airport
Norfolk, Virginia 23518
UL 3-4368

Weather Bureau Airport Station
Municipal Airport
Charleston, South Carolina 29411
SH 4-3207

Weather Bureau Airport Station
Imeson Airport
Jacksonville, Florida 32229
EL 3-7370

Weather Bureau Airport Station
East Boston, Massachusetts 02128
567-4670

Weather Bureau Airport Station
Municipal Airport
New Haven, Connecticut 06512
HO 7-1540

Weather Bureau Airport Station
National Aviation Facilities
Experimental Center
Atlantic City, New Jersey 08405
MI 1-4325

Weather Bureau Forecast Center
FOB 4, Suitland
Washington, D. C. 20233
736-3070

Weather Bureau Airport Station
Washington National Airport
Washington, D. C. 20001
628-9149

Weather Bureau Airport Station
Wilmington, North Carolina 28403
RO 2-3240

Weather Bureau Airport Station
International Airport
Miami, Florida 33159
634-7687
634-3915

GULF AREA

Weather Bureau Airport Station
Tampa International Airport
Tampa, Florida 33607
877-3617

Weather Bureau Office
Post Office Building
Pensacola, Florida 32503
HE 2-5534

Weather Bureau Airport Station
Lake Charles Air Force Base
Lake Charles, Louisiana 70604
477-5214

Weather Bureau Office
515 Post Office Building
Galveston, Texas 77550
SO 5-9479

Weather Bureau Airport Station
International Airport
Brownsville, Texas 78520
LI 2-8802

Weather Bureau Airport Station
Fort Myers, Florida 33902
WE 6-2057

Weather Bureau Airport Station
Bates Field
Mobile, Alabama 36608
342-2423

Weather Bureau Airport Station
Jefferson County Airport
Beaumont, Texas 77627
RA 2-4922

Weather Bureau Airport Station
Corpus Christi International Airport
Corpus Christi, Texas 78408
TU 4-8819

Weather Bureau Airport Station
Ryan Airport
Baton Rouge, Louisiana 70807
357-4740
357-9943

PACIFIC AREA

Weather Bureau Airport Station
International Airport
Anchorage Alaska 99502
BR 7-0801

Weather Bureau Airport Station
Clatsop County Airport
Astoria, Oregon 97103
WA 1-4131

Weather Bureau Office
Eureka, California 95503
HI 2-6594

Weather Bureau Airport Station
Oakland Municipal Airport
Oakland, California 94614
562-8573

Weather Bureau Airport Station
Honolulu International Airport
Honolulu, Hawaii 96820
852-102

U.S. Weather Bureau Office
Guam, Mariana Islands 96910
55-102

Weather Bureau Airport Station
Municipal Airport
Juneau, Alaska 99801
JU 6-3640

Weather Bureau Airport Station
5420 N.E. Marine Drive
Portland, Oregon 97218
AT 2-8600

Weather Bureau Airport Station
San Francisco International Airport
San Francisco, California 94128
761-2521

Weather Bureau Forecast Center
5651 West Manchester Avenue
Los Angeles, California 90009
776-2201

Weather Bureau Airport Station
Lindbergh Field
San Diego, California 92101
293-5065

TABLE 1

Q_c QUADRANT OF THE GLOBE CODE

Code Figure	Location of Ship	
1	NORTH Latitude,	EAST Longitude
3	SOUTH Latitude,	EAST Longitude
5	SOUTH Latitude,	WEST Longitude
7	NORTH Latitude,	WEST Longitude

Note: When the ship is sailing exactly on one of the quadrant dividing lines, the equator, the Greenwich Meridian, or the 180th Meridian, use the quadrant figure on either side of the dividing line as follows:

Choose one	Location of Ship	
1 or 7	NORTH Latitude	0° or 180° Longitude
3 or 5	SOUTH Latitude	0° or 180° Longitude
1 or 3	EQUATOR	EAST Longitude
5 or 7	EQUATOR	WEST Longitude

TABLE 2

i_W TYPE OF WIND REPORT CODE

Code Figure	Type of Wind Reported	
0	Estimated	METERS PER SECOND
1	Measured by Anemometer	
3	Estimated	KNOTS
4	Measured by Anemometer	

TABLE 3

N TOTAL CLOUD AMOUNT (SKY COVER) CODE

Code Figure	Amount of Sky Covered	Code Figure	Amount of Sky Covered
0	Cloudless	7	7/8 to overcast with openings
1	Fragments to 1/8		
2	2/8	8	Overcast without openings
3	3/8		
4	4/8	9	Sky obscured or cloud amount cannot be estimated
5	5/8		
6	6/8		

Note: An opening in an obscuration will be evaluated as if it were the whole celestial dome. Do not use 9 when any sky or clouds can be seen through the obscuration.

TABLE 4

dd TRUE WIND DIRECTION, TENS OF DEGREES

(From which the wind is blowing)

Code Figure	Direction	Code Figure	Direction
00	Calm	19	185° to 194°
01	5° to 14°	20	195° to 204°
02	15° to 24°	21	205° to 214°
03	25° to 34°	22	215° to 224°
04	35° to 44°	23	225° to 234°
05	45° to 54°	24	235° to 244°
06	55° to 64°	25	245° to 254°
07	65° to 74°	26	255° to 264°
08	75° to 84°	27	265° to 274°
09	85° to 94°	28	275° to 284°
10	95° to 104°	29	285° to 294°
11	105° to 114°	30	295° to 304°
12	115° to 124°	31	305° to 314°
13	125° to 134°	32	315° to 324°
14	135° to 144°	33	325° to 334°
15	145° to 154°	34	335° to 344°
16	155° to 164°	35	345° to 354°
17	165° to 174°	36	355° to 4°
18	175° to 184°		

Note: In case the true wind exceeds 99 knots, 50 will be added to "dd" and only the wind speed in excess of 100 knots will be coded. For example, if the direction = 163° and speed = 121 knots, the wind will be coded as "6621" (dd = 16 + 50; ff = 121 - 100).

TABLE 5

VV VISIBILITY CODE

Code Figure	Visibility Range Nautical Miles	Code Figure	Visibility Range Nautical Miles
90	Less than 50 yards	95	1 to less than 2
91	50 to 199 yards	96	2 to less than 5
92	200 yards to 1/4 n.mi.	97	5 to less than 10
93	3/8 to less than 1/2	98	10 to less than 25
94	1/2 to less than 1	99	25 or more

TABLE 6

WW PRESENT WEATHER CODE

ww = 00 - 49 No precipitation at the station at the time of observation

ww = 00 - 19 No precipitation, fog, ice fog (except 10, 11 and 12), dust-storm, sandstorm, drifting or blowing snow at the station* at the time of observation or, except for 09 and 17, during the preceding hour

Code Figure ww

00	Cloud development not observed or not observable
01	Clouds generally dissolving or becoming less developed
02	State of sky on the whole unchanged
03	Clouds generally forming or developing
04	Visibility reduced by smoke from a distant source (any source other than your ship's smoke)
05	Visibility reduced by haze
06	Dust in the air, from a distant source, reducing visibility
07	Blowing spray, reducing visibility to six miles or less, or dust or sand raised by the wind near the station

*The expression "at the station" refers to a land station or a ship.

TABLE 6--Continued

Code Figure ww	
08	Dust whirls over land seen from the ship during the preceding hour or at observation time but no duststorm or sandstorm
09	Duststorm or sandstorm at or near the ship during the past hour or at the time of observation, reducing visibility at the ship to 1/2 mile or less
10	Light fog, extending higher than the observer's eye level (33 feet above the sea) visibility more than 1/2 mile but not more than six miles
11	Patches of shallow fog, not extending higher than the observer's eye level (33 feet) visibility within the fog 1/2 mile or less. Reported visibility (eye level) more than 1/2 mile
12	Continuous shallow fog less than 33 feet deep, visibility 1/2 mile or less in the fog. Reported visibility more than 1/2 mile at eye level
13	Lightning visible at observation time or up to 15 minutes before observation but no thunder heard
14	Virga. Precipitation within sight, not reaching the ground
15	Distant precipitation (more than three miles away) reaching the sea surface
16	Precipitation reaching the sea surface near to, but not at the ship (within three miles distance)
17	Thunderstorm, but no precipitation at the time of observation
18	Squalls at or within sight of the ship at the time of observation or during the preceding hour
19	Waterspouts, funnel clouds or tornadoes at or within sight of the ship at the time of observation or during the preceding hour

TABLE 6--Continued

ww = 20 - 29 Precipitation, fog, ice fog or thunderstorm at the station during the preceding hour but not at the time of observation

Code Figure ww	
20	Drizzle (not freezing) or snow grains
21	Rain (not freezing)
22	Snow
23	Rain and snow or ice pellets, type (a)
24	Freezing drizzle or freezing rain
25	Shower(s) of rain
26	Shower(s) of snow, or of rain and snow
27	Shower(s) of hail*, or of rain and hail*
28	Fog or ice fog
29	Thunderstorm (with or without precipitation)

*Hail, ice pellets, type (b), snow pellets.

ww = 30 - 39 Duststorm, sandstorm, drifting or blowing snow

30	Light or moderate duststorm or sandstorm has decreased during the preceding hour
31	Light or moderate duststorm or sandstorm, no appreciable change during the preceding hour
32	Light or moderate duststorm or sandstorm has begun or has increased during the preceding hour
33	Severe duststorm or sandstorm has decreased during the preceding hour
34	Severe duststorm or sandstorm, no appreciable change during the preceding hour

TABLE 6--Continued

Code Figure ww		
35	Severe duststorm or sandstorm has begun or has increased during the preceding hour	
36	Light or moderate drifting snow	generally low (below eye level)
37	Heavy drifting snow	
38	Light or moderate blowing snow	generally high (above eye level)
39	Heavy blowing snow	
ww = 40 - 49	Fog or ice fog at the time of observation	
40	Fog bank at a distance at the time of observation but not at the ship during the preceding hour, extending to a height of more than 33 feet. The visibility within the fog bank estimated to be 1/2 mile or less. (Prevailing visibility (VV) at the ship may be any value.)	
ww = 41 - 49	Prevailing visibility must be 1/2 mile or less. Fog must extend above the observer's eye level (33 feet above sea surface)	
41	Fog or ice fog in patches	
42	Fog or ice fog, sky visible	has become thinner during the preceding hour
43	Fog or ice fog, sky invisible	
44	Fog or ice fog, sky visible	no appreciable change during the preceding hour
45	Fog or ice fog, sky invisible	
46	Fog or ice fog, sky visible	has begun or has become thicker during the preceding hour
47	Fog or ice fog, sky invisible	
48	Fog, depositing rime, sky visible	
49	Fog, depositing rime, sky invisible	

TABLE 6--Continued

ww = 50 - 99 Precipitation at the station at the time of observation

ww = 50 - 59 Drizzle

Code Figure ww		
50	Drizzle, not freezing, intermittent	light at time of observation
51	Drizzle, not freezing, continuous	
52	Drizzle, not freezing, intermittent	moderate at time of observation
53	Drizzle, not freezing, continuous	
54	Drizzle, not freezing, intermittent	heavy at time of observation
55	Drizzle, not freezing, continuous	
56	Drizzle, freezing, light	
57	Drizzle, freezing, moderate or heavy	
58	Drizzle and rain, light	
59	Drizzle and rain, moderate or heavy	

ww = 60 - 69 Rain

60	Rain, not freezing, intermittent	light at time of observation
61	Rain, not freezing, continuous	
62	Rain, not freezing, intermittent	moderate at time of observation
63	Rain, not freezing, continuous	
64	Rain, not freezing, intermittent	heavy at time of observation
65	Rain, not freezing, continuous	
66	Rain, freezing, light	
67	Rain, freezing, moderate or heavy	

TABLE 6--Continued

Code Figure ww		
68	Rain or drizzle and snow, light	
69	Rain or drizzle and snow, moderate or heavy	
ww = 70-79	Solid precipitation not in showers	
70	Intermittent fall of snowflakes	light at time of observation
71	Continuous fall of snowflakes	
72	Intermittent fall of snowflakes	moderate at time of observation
73	Continuous fall of snowflakes	
74	Intermittent fall of snowflakes	heavy at time of observation
75	Continuous fall of snowflakes	
76	Ice prisms (with or without fog)	
77	Snow grains (with or without fog)	
78	Isolated star-like snow crystals (with or without fog)	
79	Ice Pellets, type (a)	
ww = 80 - 89	Showery precipitation, or precipitation with current or recent thunderstorm	
80	Rain shower(s), light	
81	Rain shower(s), moderate or heavy	
82	Rain shower(s), violent	
83	Shower(s) of rain and snow mixed, light	
84	Shower(s) of rain and snow mixed, moderate or heavy	
85	Snow shower(s), light	
86	Snow shower(s), moderate or heavy	

TABLE 6--Continued

Code Figure ww		
87	Light shower(s) of snow pellets or ice pellets, type (b), with or without rain or rain and snow mixed	
88	Moderate or heavy shower(s) of snow pellets or ice pellets, type (b), with or without rain or rain and snow mixed	
89	Light shower(s) of hail*, with or without rain or rain and snow mixed, not associated with thunder	
90	Moderate or heavy shower(s) of hail*, with or without rain or rain and snow mixed, not associated with thunder	
91	Light rain at time of observation	thunderstorm during the preceding hour but not at time of observation
92	Moderate or heavy rain at time of observation	
93	Light snow, or rain and snow mixed or hail* at time of observation	
94	Moderate or heavy snow, or rain and snow mixed or hail* at time of observation	
95	Thunderstorm, light or moderate, without hail*, but with rain and/or snow at time of observation	thunderstorm at time of observation
96	Thunderstorm, light or moderate, with hail* at time of observation	
97	Thunderstorm, heavy, without hail*, but with rain and/or snow at time of observation	
98	Thunderstorm combined with dust-storm or sandstorm at time of observation	
99	Thunderstorm, heavy, with hail* at time of observation	

*Hail, ice pellets, type (b), snow pellets.

TABLE 7

SYMBOL W -- PAST WEATHER[1]

Code Figure	Past Weather
0	Cloud covering 1/2 or less of the sky throughout period.
1	Cloud covering more than 1/2 of the sky during part of period, and less than 1/2 during part of period.
2	Cloud covering more than 1/2 of sky throughout period.
3	Sandstorm, duststorm, or drifting or blowing snow.
4	Fog, or ice fog, or thick haze.
5	Drizzle.
6	Rain.
7	Snow, rain and snow mixed, or ice pellets.
8[2]	Shower(s).
9[2]	Thunderstorm(s), with or without precipitation.

[1] When precipitation or thunderstorm has occurred since the last standard hour, use code figures 5 to 9, even though the "general character" of the past weather would best be represented by a lower code figure.

[2] When code figure 8 or 9 is used to represent showers or thundershowers which were accompanied by hail, enter the words PAST HAIL in column 40 and transmit them at the end of the weather report.

TABLE 8

PPP PRESSURE, INCHES TO MILLIBARS

For values not here, multiply pressure in inches by 33.86 to get millibars.

in.	mb. cols. 14	15	in.	mb. cols. 14	15	in.	mb. cols. 14	15	in.	mb. cols. 14	15	in.	mb. cols. 14	15
28.50	9	651	29.00	9	821	29.50	9	990	30.00	10	159	30.50	10	329
28.51	9	655	29.01	9	824	29.51	9	993	30.01	10	163	30.51	10	332
28.52	9	658	29.02	9	827	29.52	9	997	30.02	10	166	30.52	10	335
28.53	9	661	29.03	9	831	29.53	10	000	30.03	10	169	30.53	10	339
28.54	9	665	29.04	9	834	29.54	10	003	30.04	10	173	30.54	10	342
28.55	9	668	29.05	9	837	29.55	10	007	30.05	10	176	30.55	10	345
28.56	9	672	29.06	9	841	29.56	10	010	30.06	10	179	30.56	10	349
28.57	9	675	29.07	9	844	29.57	10	014	30.07	10	183	30.57	10	352
28.58	9	678	29.08	9	848	29.58	10	017	30.08	10	186	30.58	10	356
28.59	9	682	29.09	9	851	29.59	10	020	30.09	10	190	30.59	10	359
28.60	9	685	29.10	9	854	29.60	10	024	30.10	10	193	30.60	10	362
28.61	9	688	29.11	9	858	29.61	10	027	30.11	10	196	30.61	10	366
28.62	9	692	29.12	9	861	29.62	10	030	30.12	10	200	30.62	10	369
28.63	9	695	29.13	9	865	29.63	10	034	30.13	10	203	30.63	10	373
28.64	9	699	29.14	9	868	29.64	10	037	30.14	10	207	30.64	10	376
28.65	9	702	29.15	9	871	29.65	10	041	30.15	10	210	30.65	10	379
28.66	9	705	29.16	9	875	29.66	10	044	30.16	10	213	30.66	10	383
28.67	9	709	29.17	9	878	29.67	10	047	30.17	10	217	30.67	10	386
28.68	9	712	29.18	9	881	29.68	10	051	30.18	10	220	30.68	10	389
28.69	9	716	29.19	9	885	29.69	10	054	30.19	10	224	30.69	10	393
28.70	9	719	29.20	9	888	29.70	10	058	30.20	10	227	30.70	10	396
28.71	9	722	29.21	9	892	29.71	10	061	30.21	10	230	30.71	10	400
28.72	9	726	29.22	9	895	29.72	10	064	30.22	10	234	30.72	10	403
28.73	9	729	29.23	9	898	29.73	10	068	30.23	10	237	30.73	10	406
28.74	9	732	29.24	9	902	29.74	10	071	30.24	10	240	30.74	10	410
28.75	9	736	29.25	9	905	29.75	10	075	30.25	10	244	30.75	10	413
28.76	9	739	29.26	9	909	29.76	10	078	30.26	10	247	30.76	10	417
28.77	9	743	29.27	9	912	29.77	10	081	30.27	10	251	30.77	10	420
28.78	9	746	29.28	9	915	29.78	10	085	30.28	10	254	30.78	10	423
28.79	9	749	29.29	9	919	29.79	10	088	30.29	10	257	30.79	10	427
28.80	9	753	29.30	9	922	29.80	10	091	30.30	10	261	30.80	10	430
28.81	9	756	29.31	9	926	29.81	10	095	30.31	10	264	30.81	10	433
28.82	9	760	29.32	9	929	29.82	10	098	30.32	10	268	30.82	10	437
28.83	9	763	29.33	9	932	29.83	10	102	30.33	10	271	30.83	10	440
28.84	9	766	29.34	9	936	29.84	10	105	30.34	10	274	30.84	10	444
28.85	9	770	29.35	9	939	29.85	10	108	30.35	10	278	30.85	10	447
28.86	9	773	29.36	9	942	29.86	10	112	30.36	10	281	30.86	10	450
28.87	9	777	29.37	9	946	29.87	10	115	30.37	10	284	30.87	10	454
28.88	9	780	29.38	9	949	29.88	10	119	30.38	10	288	30.88	10	457
28.89	9	783	29.39	9	953	29.89	10	122	30.39	10	291	30.89	10	461
28.90	9	787	29.40	9	956	29.90	10	125	30.40	10	295	30.90	10	464
28.91	9	790	29.41	9	959	29.91	10	129	30.41	10	298	30.91	10	467
28.92	9	793	29.42	9	963	29.92	10	132	30.42	10	301	30.92	10	471
28.93	9	797	29.43	9	966	29.93	10	135	30.43	10	305	30.93	10	474
28.94	9	800	29.44	9	970	29.94	10	139	30.44	10	308	30.94	10	477
28.95	9	804	29.45	9	973	29.95	10	142	30.45	10	312	30.95	10	481
28.96	9	807	29.46	9	976	29.96	10	146	30.46	10	315	30.96	10	484
28.97	9	810	29.47	9	980	29.97	10	149	30.47	10	318	30.97	10	488
28.98	9	814	29.48	9	983	29.98	10	152	30.48	10	322	30.98	10	491
28.99	9	817	29.49	9	986	29.99	10	156	30.49	10	325	30.99	10	494

Millibars in this table are to tenths, decimal omitted.

TABLE 8a

MILLIMETERS TO MILLIBARS

Mm.	0	1	2	3	4	5	6	7	8	9
	Mb.	*Mb.*	*Mb.*	*Mb.*	*Mb.*	*Mb.*	*Mb.*	*Mb.*	*Mb.*	*Mb.*
690	919. 9	921. 3	922. 6	923. 9	925. 3	926. 6	927. 9	929. 3	930. 6	931. 9
700	933. 3	934. 6	935. 9	937. 3	938. 6	939. 9	941. 3	942. 6	943. 9	945. 3
710	946. 6	947. 9	949. 3	950. 6	951. 9	953. 3	954. 6	955. 9	957. 3	958. 6
720	959. 9	961. 3	962. 2	963. 6	965. 3	966. 6	967. 9	969. 3	970. 6	971. 9
730	973. 3	974. 6	975. 9	977. 3	978. 6	979. 9	981. 3	982. 6	983. 9	985. 3
740	986. 6	987. 9	989. 3	990. 6	991. 9	993. 3	994. 6	995. 9	997. 3	998. 6
750	999. 9	1, 001. 3	1, 002. 6	1, 003. 9	1, 005. 3	1, 006. 6	1, 007. 9	1, 009. 3	1, 010. 6	1, 011. 9
760	1, 013. 3	1, 014. 6	1, 015. 9	1, 017. 2	1, 018. 6	1, 019. 9	1, 021. 2	1, 022. 6	1, 023. 9	1, 025. 2
770	1, 026. 6	1, 027. 9	1, 029. 2	1, 030. 6	1, 031. 9	1, 033. 2	1, 034. 6	1, 035. 9	1, 037. 2	1, 038. 6
780	1, 039. 9	1, 041. 2	1, 042. 6	1, 043. 9	1, 045. 2	1, 046. 6	1, 047. 9	1, 049. 2	1, 050. 6	1, 051. 9
790	1, 053. 2	1, 054. 6	1, 055. 9	1, 057. 2	1, 058. 6	1, 059. 9	1, 061. 2	1, 062. 6	1, 063. 9	1, 065. 2

TABLE 8b

CORRECTION OF MERCURIAL BAROMETER FOR TEMPERATURE (ENGLISH MEASURE)

ADD

Temperature (° F.)	Observed reading (inches)					Temperature (° F.)	Observed reading (inches)				
	28.5	29.0	29.5	30.0	30.5		28.5	29.0	29.5	30.0	30.5
0	0.07	0.08	0.08	0.08	0.08	16	0.03	0.03	0.03	0.03	0.04
1	.07	.07	.07	.08	.08	17	.03	.03	.03	.03	.03
2	.07	.07	.07	.07	.07	18	.03	.03	.03	.03	.03
3	.07	.07	.07	.07	.07	19	.02	.02	.03	.03	.03
4	.06	.06	.07	.07	.07	20	.02	.02	.02	.02	.02
5	.06	.06	.06	.06	.07	21	.02	.02	.02	.02	.02
6	.06	.06	.06	.06	.06	22	.02	.02	.02	.02	.02
7	.06	.06	.06	.06	.06	23	.02	.02	.02	.02	.02
8	.05	.05	.06	.06	.06	24	.01	.01	.01	.01	.01
9	.05	.05	.05	.05	.05	25	.01	.01	.01	.01	.01
10	.05	.05	.05	.05	.05	26	.01	.01	.01	.01	.01
11	.05	.05	.05	.05	.05	27					
12	.04	.04	.04	.04	.05	28					
13	.04	.04	.04	.04	.04	29					
14	.04	.04	.04	.04	.04	30					
15	.04	.04	.04	.04	.04						

SUBTRACT

Temperature (° F.)	Observed reading (inches)					Temperature (° F.)	Observed reading (inches)				
	28.5	29.0	29.5	30.0	30.5		28.5	29.0	29.5	30.0	30.5
31	0.01	0.01	0.01	0.01	0.01	66	0.10	0.10	0.10	0.10	0.10
32	.01	.01	.01	.01	.01	67	.10	.10	.10	.10	.11
33	.01	.01	.01	.01	.01	68	.10	.10	.10	.11	.11
34	.01	.01	.01	.02	.02	69	.10	.11	.11	.11	.11
35	.02	.02	.02	.02	.02	70	.11	.11	.11	.11	.11
36	.02	.02	.02	.02	.02	71	.11	.11	.11	.12	.12
37	.02	.02	.02	.02	.02	72	.11	.11	.12	.12	.12
38	.02	.02	.02	.03	.03	73	.11	.12	.12	.12	.12
39	.03	.03	.03	.03	.03	74	.12	.12	.12	.12	.12
40	.03	.03	.03	.03	.03	75	.12	.12	.12	.13	.13
41	.03	.03	.03	.03	.03	76	.12	.12	.13	.13	.13
42	.04	.04	.04	.04	.04	77	.12	.13	.13	.13	.13
43	.04	.04	.04	.04	.04	78	.13	.13	.13	.13	.14
44	.04	.04	.04	.04	.04	79	.13	.13	.14	.14	.14
45	.04	.04	.04	.04	.04	80	.13	.14	.14	.14	.14
46	.04	.05	.05	.05	.05	81	.14	.14	.14	.14	.14
47	.05	.05	.05	.05	.05	82	.14	.14	.14	.14	.15
48	.05	.05	.05	.05	.05	83	.14	.14	.14	.15	.15
49	.05	.05	.05	.06	.06	84	.14	.14	.15	.15	.15
50	.06	.06	.06	.06	.06	85	.15	.15	.15	.15	.16
51	.06	.06	.06	.06	.06	86	.15	.15	.15	.16	.16
52	.06	.06	.06	.06	.06	87	.15	.15	.16	.16	.16
53	.06	.06	.06	.07	.07	88	.15	.16	.16	.16	.16
54	.06	.07	.07	.07	.07	89	.16	.16	.16	.16	.17
55	.07	.07	.07	.07	.07	90	.16	.16	.16	.17	.17
56	.07	.07	.07	.07	.08	91	.16	.16	.17	.17	.17
57	.07	.08	.08	.08	.08	92	.16	.17	.17	.17	.18
58	.08	.08	.08	.08	.08	93	.17	.17	.17	.17	.18
59	.08	.08	.08	.08	.08	94	.17	.17	.17	.18	.18
60	.08	.08	.08	.08	.09	95	.17	.17	.18	.18	.18
61	.08	.08	.09	.09	.09	96	.17	.18	.18	.18	.19
62	.09	.09	.09	.09	.09	97	.18	.18	.18	.18	.19
63	.09	.09	.09	.09	.10	98	.18	.18	.18	.19	.19
64	.09	.09	.10	.10	.10	99	.18	.18	.19	.19	.19
65	.09	.10	.10	.10	.10	100	.18	.19	.19	.19	.20

TABLE 8c

REDUCTION OF BAROMETRIC READING TO MEAN SEA LEVEL
(Reading, 30 inches. The correction is always to be added)

Height in feet	Temperature of air (dry bulb)									
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
10	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
15	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
20	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
25	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
30	.04	.04	.04	.03	.03	.03	.03	.03	.03	.03
35	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
40	.05	.05	.05	.05	.04	.04	.04	.04	.04	.04
45	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
50	.06	.06	.06	.06	.06	.05	.05	.05	.05	.05
55	.07	.07	.06	.06	.06	.06	.06	.06	.06	.06
60	.07	.07	.07	.07	.07	.07	.06	.06	.06	.06
65	.08	.08	.08	.07	.07	.07	.07	.07	.07	.07
70	.09	.08	.08	.08	.08	.08	.08	.07	.07	.07
75	.09	.09	.09	.09	.08	.08	.08	.08	.08	.08
80	.10	.10	.09	.09	.09	.09	.09	.08	.08	.08
85	.10	.10	.10	.10	.10	.09	.09	.09	.09	.09
90	.11	.11	.11	.10	.10	.10	.10	.09	.09	.09
95	.12	.11	.11	.11	.11	.10	.10	.10	.10	.10
100	.12	.12	.12	.11	.11	.11	.11	.11	.10	.10

TABLE 8d

REDUCTION OF THE MERCURIAL BAROMETER TO STANDARD GRAVITY
(980.665 cm/sec^2) (30 inches)

Lat.	Cor.	Lat.	Cor.	Lat.	Cor.	Lat.	Cor.
°	Inch	°	Inch	°	Inch	°	Inch
0	-0.08	25	-0.05	45	0.00	70	+0.06
5	-.08	30	-.04	50	+.01	75	+.07
10	-.08	35	-.03	55	+.03	80	+.07
15	-.07	40	-.02	60	+.04	85	+.08
20	-.06	45	0.00	65	+.05	90	+.08

TABLE 9

TTtT FAHRENHEIT TO CELSIUS TEMPERATURES

°F.	0.0 °C.	0.1 °C.	0.2 °C.	0.3 °C.	0.4 °C.	0.5 °C.	0.6 °C.	0.7 °C.	0.8 °C.	0.9 °C.
+110	+43.3	+43.4	+43.4	+43.5	+43.6	+43.6	+43.7	+43.7	+43.8	+43.8
109	42.8	42.8	42.9	42.9	43.0	43.1	43.1	43.2	43.2	43.3
108	42.2	42.3	42.3	42.4	42.4	42.5	42.6	42.6	42.7	42.7
107	41.7	41.7	41.8	41.8	41.9	41.9	42.0	42.1	42.1	42.2
106	41.1	41.2	41.2	41.3	41.3	41.4	41.4	41.5	41.6	41.6
+105	+40.6	+40.6	+40.7	+40.7	+40.8	+40.8	+40.9	+40.9	+41.0	+41.1
104	40.0	40.1	40.1	40.2	40.2	40.3	40.3	40.4	40.4	40.5
103	39.4	39.5	39.6	39.6	39.7	39.7	39.8	39.8	39.9	39.9
102	38.9	38.9	39.0	39.1	39.1	39.2	39.2	39.3	39.3	39.4
101	38.3	38.4	38.4	38.5	38.6	38.6	38.7	38.7	38.8	38.8
+100	+37.8	+37.8	+37.9	+37.9	+38.0	+38.1	+38.1	+38.2	+38.2	+38.3
99	37.2	37.3	37.3	37.4	37.4	37.5	37.6	37.6	37.7	37.7
98	36.7	36.7	36.8	36.8	36.9	36.9	37.0	37.1	37.1	37.2
97	36.1	36.2	36.2	36.3	36.3	36.4	36.4	36.5	36.6	36.6
96	35.6	35.6	35.7	35.7	35.8	35.8	35.9	35.9	36.0	36.1
+95	+35.0	+35.1	+35.1	+35.2	+35.2	+35.3	+35.3	+35.4	+35.4	+35.5
94	34.4	34.5	34.6	34.6	34.7	34.7	34.8	34.8	34.9	34.9
93	33.9	33.9	34.0	34.1	34.1	34.2	34.2	34.3	34.3	34.4
92	33.3	33.4	33.4	33.5	33.6	33.6	33.7	33.7	33.8	33.8
91	32.8	32.8	32.9	32.9	33.0	33.1	33.1	33.2	33.2	33.3
+90	+32.2	+32.3	+32.3	+32.4	+32.4	+32.5	+32.6	+32.6	+32.7	+32.7
89	31.7	31.7	31.8	31.8	31.9	31.9	32.0	32.1	32.1	32.2
88	31.1	31.2	31.2	31.3	31.3	31.4	31.4	31.5	31.6	31.6
87	30.6	30.6	30.7	30.7	30.8	30.8	30.9	30.9	31.0	31.1
86	30.0	30.1	30.1	30.2	30.2	30.3	30.3	3.04	30.4	30.5
+85	+29.4	+29.5	+29.6	+29.6	+29.7	+29.7	+29.8	+29.8	+29.9	+29.9
84	28.9	28.9	29.0	29.1	29.1	29.2	29.2	29.3	29.3	29.4
83	28.3	28.4	28.4	28.5	28.6	28.6	28.7	28.7	28.8	28.8
82	27.8	27.8	27.9	27.9	28.0	28.1	28.1	28.2	28.2	28.3
81	27.2	27.3	27.3	27.4	27.4	27.5	27.6	27.6	27.7	27.7
+80	+26.7	+26.7	+26.8	+26.8	+26.9	+26.9	+27.0	+27.1	+27.1	+27.2
79	26.1	26.2	26.2	26.3	26.3	26.4	26.4	26.5	26.6	26.6
78	25.6	25.6	25.7	25.7	25.8	25.8	25.9	25.9	26.0	26.1
77	25.0	25.1	25.1	25.2	25.2	25.3	25.3	25.4	25.4	25.5
76	24.4	24.5	24.6	24.6	24.7	24.7	24.8	24.8	24.9	24.9

TABLE 9--Continued

°F.	0.0 °C.	0.1 °C.	0.2 °C.	0.3 °C.	0.4 °C.	0.5 °C.	0.6 °C.	0.7 °C.	0.8 °C.	0.9 °C.
+75	+23.9	+23.9	+24.0	+24.1	+24.1	+24.2	+24.2	+24.3	+24.3	+24.4
74	23.3	23.4	23.4	23.5	23.6	23.6	23.7	23.7	23.8	23.8
73	22.8	22.8	22.9	22.9	23.0	23.1	23.1	23.2	23.2	23.3
72	22.2	22.3	22.3	22.4	22.4	22.5	22.6	22.6	22.7	22.7
71	21.7	21.7	21.8	21.8	21.9	21.9	22.0	22.1	22.1	22.2
+70	+21.1	+21.2	+21.2	+21.3	+21.3	+21.4	+21.4	+21.5	+21.6	+21.6
69	20.6	20.6	20.7	20.7	20.8	20.8	20.9	20.9	21.0	21.1
68	20.0	20.1	20.1	20.2	20.2	20.3	20.3	20.4	20.4	20.5
67	19.4	19.5	19.6	19.6	19.7	19.7	19.8	19.8	19.9	19.9
66	18.9	18.9	19.0	19.1	19.1	19.2	19.2	19.3	19.3	19.4
+65	+18.3	+18.4	+18.4	+18.5	+18.6	+18.6	+18.7	+18.7	+18.8	+18.8
64	17.8	17.8	17.9	17.9	18.0	18.1	18.1	18.2	18.2	18.3
63	17.2	17.3	17.3	17.4	17.4	17.5	17.6	17.6	17.7	17.7
62	16.7	16.7	16.8	16.8	16.9	16.9	17.0	17.1	17.1	17.2
61	16.1	16.2	16.2	16.3	16.3	16.4	16.4	16.5	16.6	16.6
+60	+15.6	+15.6	+15.7	+15.7	+15.8	+15.8	+15.8	+15.9	+16.0	+16.1
59	15.0	15.1	15.1	15.2	15.2	15.3	15.3	15.4	15.4	15.5
58	14.4	14.5	14.6	14.6	14.7	14.7	14.8	14.8	14.9	14.9
57	13.9	13.9	14.0	14.1	14.1	14.2	14.2	14.3	14.3	14.4
56	13.3	13.4	13.4	13.5	13.6	13.6	13.7	13.7	13.8	13.8
+55	+12.8	+12.8	+12.9	+12.9	+13.0	+13.1	+13.1	+13.2	+13.2	+13.3
54	12.2	12.3	12.3	12.4	12.4	12.5	12.6	12.6	12.7	12.7
53	11.7	11.7	11.8	11.8	11.9	11.9	12.0	12.1	12.1	12.2
52	11.1	11.2	11.2	11.3	11.3	11.4	11.4	11.5	11.6	11.6
51	10.6	10.6	10.7	10.7	10.8	10.8	10.9	10.9	11.0	11.1
+50	+10.0	+10.1	+10.1	+10.2	+10.2	+10.3	+10.3	+10.4	+10.4	+10.5
49	9.4	9.5	9.6	9.6	9.7	9.7	9.8	9.8	9.9	9.9
48	8.9	8.9	9.0	9.1	9.1	9.2	9.2	9.3	9.3	9.4
47	8.3	8.4	8.4	8.5	8.6	8.6	8.7	8.7	8.8	8.8
46	7.8	7.8	7.9	7.9	8.0	8.1	8.1	8.2	8.2	8.3
+45	+7.2	+7.3	+7.3	+7.4	+7.4	+7.5	+7.6	+7.6	+7.7	+7.7
44	6.7	6.7	6.8	6.8	6.9	6.9	7.0	7.1	7.1	7.2
43	6.1	6.2	6.2	6.3	6.3	6.4	6.4	6.5	6.6	6.6
42	5.6	5.6	5.7	5.7	5.8	5.8	5.9	5.9	6.0	6.1
41	5.0	5.1	5.1	5.2	5.2	5.3	5.3	5.4	5.4	5.5

TABLE 9--Continued

°F.	0.0 °C.	0.1 °C.	0.2 °C.	0.3 °C.	0.4 °C.	0.5 °C.	0.6 °C.	0.7 °C.	0.8 °C.	0.9 °C.
+40	+4.4	+4.5	+4.6	+4.6	+4.7	+4.7	+4.8	+4.8	+4.9	+4.9
39	3.9	3.9	4.0	4.1	4.1	4.2	4.2	4.3	4.3	4.4
38	3.3	3.4	3.4	3.5	3.6	3.6	3.7	3.7	3.8	3.8
37	2.8	2.8	2.9	2.9	3.0	3.1	3.1	3.2	3.2	3.3
36	2.2	2.3	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.7
+35	+1.7	+1.7	+1.8	+1.8	+1.9	+1.9	+2.0	+2.1	+2.1	+2.2
34	+1.1	+1.2	+1.2	+1.3	+1.3	+1.4	+1.4	+1.5	+1.6	+1.6
33	+0.6	+0.6	+0.7	+0.7	+0.8	+0.8	+0.9	+0.9	+1.0	+1.1
32	0.0	+0.1	+0.1	+0.2	+0.2	+0.3	+0.3	+0.4	+0.4	+0.5
31	-0.6	-0.5	-0.4	-0.4	-0.3	-0.3	-0.2	-0.2	-0.1	-0.1
+30	-1.1	-1.1	-1.0	-0.9	-0.9	-0.8	-0.8	-0.7	-0.7	-0.6
29	-1.7	-1.6	-1.6	-1.5	-1.4	-1.4	-1.3	-1.3	-1.2	-1.2
28	-2.2	-2.2	-2.1	-2.1	-2.0	-1.9	-1.9	-1.8	-1.8	-1.7
27	-2.8	-2.7	-2.7	-2.6	-2.6	-2.5	-2.4	-2.4	-2.3	-2.3
26	-3.3	-3.3	-3.2	-3.2	-3.1	-3.1	-3.0	-2.9	-2.9	-2.8
+25	-3.9	-3.8	-3.8	-3.7	-3.7	-3.6	-3.6	-3.5	-3.4	-3.4
24	-4.4	-4.4	-4.3	-4.3	-4.2	-4.2	-4.1	-4.1	-4.0	-3.9
23	-5.0	-4.9	-4.9	-4.8	-4.8	-4.7	-4.7	-4.6	-4.6	-4.5
22	-5.6	-5.5	-5.4	-5.4	-5.3	-5.3	-5.2	-5.2	-5.1	-5.1
21	-6.1	-6.1	-6.0	-5.9	-5.9	-5.8	-5.8	-5.7	-5.7	-5.6
+20	-6.7	-6.6	-6.6	-6.5	-6.4	-6.4	-6.3	-6.3	-6.2	-6.2
19	-7.2	-7.2	-7.1	-7.1	-7.0	-6.9	-6.9	-6.8	-6.8	-6.7
18	-7.8	-7.7	-7.7	-7.6	-7.6	-7.5	-7.4	-7.4	-7.3	-7.3
17	-8.3	-8.3	-8.2	-8.2	-8.1	-8.1	-8.0	-7.9	-7.9	-7.8
16	-8.9	-8.8	-8.8	-8.7	-8.7	-8.6	-8.6	-8.5	-8.4	-8.4
+15	-9.4	-9.4	-9.3	-9.3	-9.2	-9.2	-9.1	-9.1	-9.0	-8.9
14	-10.0	-9.9	-9.9	-9.8	-9.8	-9.7	-9.7	-9.6	-9.6	-9.5
13	-10.6	-10.5	-10.4	-10.4	-10.3	-10.3	-10.2	-10.2	-10.1	-10.1
12	-11.1	-11.1	-11.0	-10.9	-10.9	-10.8	-10.8	-10.7	-10.7	-10.6
11	-11.7	-11.6	-11.6	-11.5	-11.4	-11.4	-11.3	-11.3	-11.2	-11.2

Note: Negative values in °C shall be encoded before entry in the ship's code for TTt_T or $T_WT_WT_W$ by adding 50.0 to the absolute value in °C and omitting the decimal in the result. E.g., a temperature of -11.7 is encoded for entry as (-11.7 +50.0) "617". The wet bulb temperature is entered as read from this table without the use of this coding technique.

TABLE 10

TOTAL AMOUNT OF ALL LOW CLOUDS (C_L) OR IF NONE, ALL MIDDLE CLOUDS (C_M) PRESENT

N_h

Code Figure	Amount of Sky Covered	Code Figure	Amount of Sky Covered
0	No C_L or C_M Clouds	5	5/8
1	Fragments to 1/8	6	6/8
2	2/8	7	7/8 to overcast with openings
3	3/8	8	Overcast without openings
4	4/8	9	Sky obscured or cloud amount cannot be estimated

TABLE 11

C_L LOW CLOUD CODE

Symbol C_L—Clouds of types Stratocumulus, Stratus, Cumulus, and Cumulonimbus

Code figures	Technical language specifications	Plain language specifications
0	No C_L clouds	No Cumulus, Cumulonimbus, Stratocumulus or Stratus.
1	Cumulus humilis, or Cumulus fractus other than of bad weather, or both.	Cumulus with little vertical extent and seemingly flattened, or ragged Cumulus other than of bad weather, or both.
2	Cumulus mediocris or congestus, with or without Cumulus of species fractus or humilis, or Stratocumulus; all having their bases at the same level.	Cumulus of moderate or strong vertical extent generally with protuberances in the form of domes or towers, either accompanied or not by other Cumulus or by Stratocumulus; all having their bases at the same level.
3	Cumulonimbus calvus, with or without Cumulus, Stratocumulus or Stratus.	Cumulonimbus the summits of which, at least partially, lack sharp outlines, but are neither clearly fibrous (cirriform), nor in the form of an anvil; Cumulus, Stratocumulus or Stratus may be present.
4	Stratocumulus cumulogenitus	Stratocumulus formed by the spreading out of Cumulus; Cumulus may also be present.
5	Stratocumulus other than Stratocumulus cumulogenitus.	Stratocumulus not resulting from the spreading out of Cumulus.
6	Stratus nebulosus or Stratus fractus other than of bad weather, or both.	Stratus in a more or less continuous sheet or layer, or in ragged shreds or both, but no Stratus fractus of bad weather.
7	Stratus fractus or Cumulus fractus of bad weather or both (pannus) usually below Altostratus or Nimbostratus.	Stratus fractus of bad weather or Cumulus fractus of bad weather or both (pannus) usually below Altostratus or Nimbostratus.
8	Cumulus and Stratocumulus, other than Stratocumulus cumulogenitus, with bases at different levels.	Cumulus and Stratocumulus, other than those formed from the spreading out of Cumulus; the base of Cumulus is at a different level than that of the Stratocumulus.
9	Cumulonimbus capillatus (often with an anvil), with or without Cumulonimbus calvus, Cumulus, Stratocumulus, Stratus or pannus.	Cumulonimbus, the upper part of which is clearly fibrous (cirriform) often in the form of an anvil; either accompanied, or not by Cumulonimbus without anvil or fibrous upper part, by Cumulus, Stratocumulus, Stratus, or pannus.
	Clouds C_L not visible owing to darkness, fog, blowing dust or sand, or other similar phenomena.	No Cumulus, Cumulonimbus, Stratocumulus or Stratus visible owing to darkness, fog, blowing dust or sand, or other similar phenomena.

NOTE: "Bad Weather" denotes the conditions which generally exist during precipitation and a short time before and after.

TABLE 12

h HEIGHT OF LOWEST CLOUD SEEN

Code Figure	Height in feet	Code Figure	Height in feet
0	0 to 149	6	3500 to 4999
1	150 to 299	7	5000 to 6499
2	300 to 599	8	6500 to 7999
3	600 to 999	9	8000 or higher or no clouds
4	1000 to 1999	/	Height cannot be estimated
5	2000 to 3499		

TABLE 13

C_M MIDDLE CLOUD CODE

Symbol C_M—Clouds of types Altocumulus, Altostratus, and Nimbostratus

Code figures	Technical language specifications	Plain language specifications
0	No C_M clouds	No Altocumulus, Altcstratus or Nimbostratus.
1	Altostratus translucidus	Altostratus, the greater part of which is semitransparent; through this part the sun or moon may be weakly visible as through ground glass.
2	Altostratus opacus or Nimbostratus.	Altostratus, the greater part of which is sufficiently dense to hide the sun (or moon), or Nimbostratus.
3	Altocumulus translucidus at a single level.	Altocumulus, the greater part of which is semitransparent; the various elements of the cloud change only slowly and are all at a single level.
4	Patches of Altocumulus translucidus (often lenticular), continuously changing and occurring at one or more levels.	Patches (often in the form of almonds or fishes) of Altocumulus, the greater part of which is semitransparent; the clouds occur at one or more levels and the elements are continually changing in appearance.
5	Altocumulus translucidus in bands, or one or more layers of Altocumulus translucidus or opacus progressively invading the sky; these Altocumulus clouds generally thicken as a whole.	Semitransparent Altocumulus in bands or Altocumulus in one or more fairly continuous layers (semitransparent or opaque) progressively invading the sky; these Altocumulus clouds generally thicken as a whole.
6	Altocumulus cumulogenitus (or cumulonimbogenitus).	Altocumulus resulting from the spreading out of Cumulus (or Cumulonimbus).
7	Altocumulus translucidus or opacus in 2 or more layers, or Altocumulus opacus in a single layer, not progressively invading the sky, or Altocumulus with Altostratus or Nimbostratus.	Altocumulus in two or more layers usually opaque in places and not progressively invading the sky; or opaque layer of Altocumulus not progressively invading the sky; or Altocumulus together with Altostratus or Nimbostratus.
8	Altocumulus castellanus or floccus.	Altocumulus with sproutings in the form of small towers or battlements, or Altocumulus having the appearance of cumuliform tufts.
9	Altocumulus of a chaotic sky, generally at several levels.	Altocumulus of a chaotic sky generally at several levels.
/	Clouds C_M not visible owing to darkness, fog, blowing dust or sand, or other similar phenomena, or because of a continuous layer of lower clouds.	No Altocumulus, Altostratus or Nimbostratus visible owing to darkness, fog, blowing dust or sand, or other similar phenomena, or more often because of the presence of a continuous layer of lower clouds.

TABLE 14

C_H HIGH CLOUD CODE

Symbol C_H—Clouds of types Cirrus, Cirrostratus, and Cirrocumulus

Code figures	Technical language specifications	Plain language specifications
0	No C_H clouds	No Cirrus, Cirrostratus or Cirrocumulus.
1	Cirrus fibratus, sometimes uncinus, not progressively invading the sky.	Cirrus in the form of filaments, strands or hooks, not progressively invading the sky.
2	Cirrus spissatus, in patches or entangled sheaves, which usually do not increase and sometimes seem to be the remains of the upper part of a Cumulonimbus; or Cirrus castellanus or floccus.	Dense Cirrus in patches or entangled sheaves which usually do not increase and sometimes seem to be the remains of the upper parts of Cumulonimbus; or Cirrus with sproutings in the form of small turrets or battlements or Cirrus having the appearance of cumuliform tufts.
3	Cirrus spissatus cumulonimbogenitus.	Dense Cirrus often in the form of an anvil, being the remains of the upper parts of Cumulonimbus.
4	Cirrus uncinus, or fibratus, or both, progressively invading the sky; they generally thicken as a whole.	Cirrus in the form of hooks or filaments or both, progressively invading the sky; they generally become denser as a whole.
5	Cirrus, often in bands, and Cirrostratus, or Cirrostratus alone, progressively invading the sky; they generally thicken as a whole, but the continuous veil does not reach 45° above the horizon.	Cirrus, often in bands converging towards 1 point or 2 opposite points of the horizon and Cirrostratus, or Cirrostratus alone; in either case they are progressively invading the sky, and generally growing denser as a whole, but the continuous veil does not reach 45° above the horizon.
6	Cirrus, often in bands, and Cirrostratus, or Cirrostratus alone, progressively invading the sky; they generally thicken as a whole, but the continuous veil extends more than 45° above the horizon, without the sky being totally covered.	Cirrus, often in bands converging towards 1 point or 2 opposite points of the horizon, and Cirrostratus, or Cirrostratus alone; in either case they are progressively invading the sky, and generally growing denser as a whole; the continuous veil extends more than 45° above the horizon, without the sky being completely covered.
7	Cirrostratus covering the whole sky.	Veil of Cirrostratus covering the celestial dome.
8	Cirrostratus not progressively invading the sky, and not entirely covering it.	Cirrostratus not progressively invading the sky, and not completely covering the celestial dome.
9	Cirrocumulus alone, or Cirrocumulus predominant among the cirriform clouds.	Cirrocumulus alone, or Cirrocumulus accompanied by Cirrus or Cirrostratus or both, but Cirrocumulus is predominant.
	Clouds C_H not visible owing to darkness, fog, blowing dust or sand or other similar phenomena, or because of a continuous layer of lower clouds.	No Cirrus, Cirrostratus or Cirrocumulus visible owing to darkness, fog, blowing dust or sand, or other similar phenomena, or more often because of the presence of a continuous layer of lower clouds.

TABLE 15

D_S SHIP'S AVERAGE COURSE OVER PAST 3 HOURS

Code Figure	True Course	Code Figure	True Course
0	Ship hove to	5	SW
1	NE	6	W
2	E	7	NW
3	SE	8	N
4	S	9	No information

TABLE 16

V_S SHIP'S AVERAGE SPEED OVER PAST 3 HOURS

Code Figure	Speed	Code Figure	Speed
0	Ship stopped	5	21 to 25 knots
1	1 to 5 knots	6	26 to 30 knots
2	6 to 10 knots	7	31 to 35 knots
3	11 to 15 knots	8	36 to 40 knots
4	16 to 20 knots	9	Over 40 knots

TABLE 17

a Barometer change characteristics in the last 3 hours

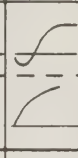
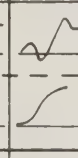
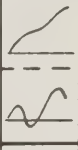
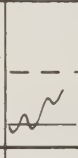
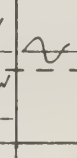
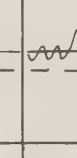
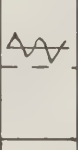
DESCRIPTION OF CHARACTERISTIC		NOMINAL GRAPHIC REPRESENTATION (For Coding Purposes)								Code Figure
PRIMARY UNQUALIFIED REQUIREMENT	ADDITIONAL REQUIREMENTS	A	B	C	D	E	F	G	H	
HIGHER Atmospheric pressure now higher than 3 hours ago.	Increasing, then decreasing.									0
	Increasing, then steady; or increasing, then increasing more slowly.									1
	Increasing: Steadily / Unsteadily									2
	Decreasing or steady, then increasing; or increasing, then increasing more rapidly.									3
THE SAME Atmospheric pressure now same as 3 hours ago.	Increasing, then decreasing.									0
	Steady									4
	Decreasing, then increasing.									5
LOWER Atmospheric pressure now lower than 3 hours ago.	Decreasing, then increasing.									5
	Decreasing, then steady; or decreasing, then decreasing more slowly.									6
	Decreasing: Steadily / Unsteadily									7
	Steady or increasing, then decreasing; or decreasing, then decreasing more rapidly.									8

TABLE 18

pp AMOUNT OF PRESSURE CHANGE IN THE LAST THREE HOURS*

Code Figure	Milli-bars	Inches of Mercury	Code Figure	Milli-bars	Inches of Mercury	Code Figure	Milli-bars	Inches of Mercury
00	0.0	.000	33	3.3	--	66	6.6	.195
01	0.1	--	34	3.4	.100	67	6.7	--
02	0.2	.005	35	3.5	--	68	6.8	.200
03	0.3	.010	36	3.6	.105	69	6.9	.205
04	0.4	--	37	3.7	.110	70	7.0	--
05	0.5	.015	38	3.8	--	71	7.1	.210
06	0.6	--	39	3.9	.115	72	7.2	--
07	0.7	.020	40	4.0	--	73	7.3	.215
08	0.8	.025	41	4.1	.120	74	7.4	--
09	0.9	--	42	4.2	.125	75	7.5	.220
10	1.0	.030	43	4.3	--	76	7.6	.225
11	1.1	--	44	4.4	.130	77	7.7	--
12	1.2	.035	45	4.5	--	78	7.8	.230
13	1.3	--	46	4.6	.135	79	7.9	--
14	1.4	.040	47	4.7	.140	80	8.0	.235
15	1.5	.045	48	4.8	--	81	8.1	.240
16	1.6	--	49	4.9	.145	82	8.2	--
17	1.7	.050	50	5.0	-	83	8.3	.245
18	1.8	--	51	5.1	.150	84	8.4	--
19	1.9	.055	52	5.2	.155	85	8.5	.250
20	2.0	.060	53	5.3	--	86	8.6	.255
21	2.1	--	54	5.4	.160	87	8.7	--
22	2.2	.065	55	5.5	--	88	8.8	.260
23	2.3	--	56	5.6	.165	89	8.9	--
24	2.4	.070	57	5.7	--	90	9.0	.265
25	2.5	.075	58	5.8	.170	91	9.1	.270
26	2.6	--	59	5.9	.175	92	9.2	--
27	2.7	.080	60	6.0	--	93	9.3	.275
28	2.8	--	61	6.1	.180	94	9.4	--
29	2.9	.085	62	6.2	--	95	9.5	.280
30	3.0	.090	63	6.3	.185	96	9.6	--
31	3.1	--	64	6.4	.190	97	9.7	.285
32	3.2	.095	65	6.5	--	98	9.8	.290

*When the amount of pressure change equals or exceeds 9.9 millibars, the code group "99ppp" will be inserted in the weather report immediately following the "$D_s V_s$ app" group. When the group is inserted, "pp" in the regular group is encoded "99" for all values higher than 9.8 millibars. The additive groups are found in Table 18a.

99ppp

TABLE 18a

PRESSURE CHANGE 9.9 MILLIBARS (.295 in.) OR MORE

Added Code Group	Milli-bars	Inches of Mercury	Added Code Group	Milli-bars	Inches of Mercury	Added Code Group	Milli-bars	Inches of Mercury
99099	9.9	--	99134	13.4	.395	99169	16.9	.500
99100	10.0	.295	99135	13.5	.400	99170	17.0	--
99101	10.1	--	99136	13.6	--	99171	17.1	.505
99102	10.2	.300	99137	13.7	.405	99172	17.2	--
99103	10.3	.305	99138	13.8	--	99173	17.3	.510
99104	10.4	--	99139	13.9	.410	99174	17.4	.515
99105	10.5	.310	99140	14.0	--	99175	17.5	--
99106	10.6	--	99141	14.1	.415	99176	17.6	.520
99107	10.7	.315	99142	14.2	.420	99177	17.7	--
99108	10.8	.320	99143	14.3	--	99178	17.8	.525
99109	10.9	--	99144	14.4	.425	99179	17.9	.530
99110	11.0	.325	99145	14.5	--	99180	18.0	--
99111	11.1	--	99146	14.6	.430	99181	18.1	.535
99112	11.2	.330	99147	14.7	.435	99182	18.2	--
99113	11.3	.335	99148	14.8	--	99183	18.3	.540
99114	11.4	--	99149	14.9	.440	99184	18.4	--
99115	11.5	.340	99150	15.0	--	99185	18.5	.545
99116	11.6	--	99151	15.1	.445	99186	18.6	.550
99117	11.7	.345	99152	15.2	.450	99187	18.7	--
99118	11.8	--	99153	15.3	--	99188	18.8	.555
99119	11.9	.350	99154	15.4	.455	99189	18.9	--
99120	12.0	.355	99155	15.5	--	99190	19.0	.560
99121	12.1	--	99156	15.6	.460	99191	19.1	.565
99122	12.2	.360	99157	15.7	.465	99192	19.2	--
99123	12.3	--	99158	15.8	--	99193	19.3	.570
99124	12.4	.365	99159	15.9	.470	99194	19.4	--
99125	12.5	.370	99160	16.0	--	99195	19.5	.575
99126	12.6	--	99161	16.1	.475	99196	19.6	.580
99127	12.7	.375	99162	16.2	--	99197	19.7	--
99128	12.8	--	99163	16.3	.480	99198	19.8	.585
99129	12.9	.380	99164	16.4	.485	99199	19.9	--
99130	13.0	.385	99165	16.5	--	99200	20.0	.590
99131	13.1	--	99166	16.6	.490	99201	20.1	.595
99132	13.2	.390	99167	16.7	--	99202	20.2	--
99133	13.3	--	99168	16.8	.495	99203	20.3	.600

TABLE 19

T_dT_d TEMPERATURE OF THE DEW POINT IN DEGREES CELSIUS*

(Tabular values are dew points with respect to water)

Wet-bulb temperature (°C.)	Depression of the wet-bulb thermometer (dry-bulb minus wet-bulb)																			
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9
-20.0	72	73	74	75	76	77	78	79	80	82	83	85	88	91	95					
-19.5	72	72	73	74	75	76	77	78	79	80	82	84	86	88	91	96				
-19.0	71	72	73	73	74	75	76	77	78	79	81	82	84	86	89	92	98			
-18.5	71	71	72	73	73	74	75	76	77	78	80	81	83	84	87	89	93	99		
-18.0	70	71	71	72	73	74	74	75	76	77	78	80	81	83	85	87	90	94	00	
-17.5	70	70	71	71	72	73	74	75	75	76	77	79	80	81	83	85	87	90	94	01
-17.0	69	70	70	71	71	72	73	74	75	75	76	77	79	80	81	83	85	87	90	94
-16.5	68	69	70	70	71	71	72	73	74	75	75	76	77	79	80	81	83	85	87	90
-16.0	68	68	69	70	70	71	71	72	73	74	75	75	76	77	79	80	81	83	85	87
-15.5	67	68	68	69	70	70	71	71	72	73	74	74	75	76	77	78	80	81	83	85
-15.0	67	67	68	68	69	69	70	71	71	72	73	74	74	75	76	77	78	80	81	83
-14.5	66	67	67	68	68	69	69	70	71	71	72	73	73	74	75	76	77	78	79	81
-14.0	66	66	67	67	68	68	69	69	70	70	71	72	72	73	74	75	76	77	78	79
-13.5	65	66	66	66	67	67	68	68	69	70	70	71	72	72	73	74	75	76	77	78
-13.0	65	65	65	66	66	67	67	68	68	69	69	70	71	71	72	73	73	74	75	76
-12.5	64	64	65	65	66	66	67	67	68	68	69	69	70	70	71	72	72	73	74	75
-12.0	63	64	64	65	65	66	66	66	67	67	68	68	69	70	70	71	71	72	73	74
-11.5	63	63	64	64	64	65	65	66	66	67	67	68	68	69	69	70	70	71	72	72
-11.0	62	63	63	63	64	64	65	65	65	66	66	67	67	68	68	69	69	70	71	71
-10.5	62	62	63	63	63	64	64	64	65	65	66	66	67	67	68	68	69	69	70	70
-10.0	61	62	62	62	63	63	63	64	64	64	65	65	66	66	67	67	68	68	69	69
-9.5	61	61	61	62	62	62	63	63	63	64	64	65	65	65	66	66	67	67	68	68
-9.0	60	60	61	61	61	62	62	62	63	63	63	64	64	65	65	65	66	66	67	67
-8.5	60	60	60	60	61	61	61	62	62	62	63	63	64	64	64	65	65	66	66	66
-8.0	59	59	60	60	60	60	61	61	61	62	62	62	63	63	64	64	64	65	65	66
-7.5	58	59	59	59	60	60	60	60	61	61	61	62	62	62	63	63	63	64	64	65
-7.0	58	58	58	59	59	59	60	60	60	60	61	61	61	62	62	62	63	63	63	64
-6.5	57	58	58	58	58	59	59	59	59	60	60	60	61	61	61	62	62	62	63	63
-6.0	57	57	57	58	58	58	58	59	59	59	59	60	60	60	61	61	61	61	62	62
-5.5	56	56	57	57	57	57	58	58	58	58	59	59	59	60	60	60	60	61	61	61
-5.0	56	56	56	56	57	57	57	57	58	58	58	58	59	59	59	59	60	60	60	61
-4.5	55	55	56	56	56	56	56	57	57	57	57	58	58	58	58	59	59	59	59	60
-4.0	55	55	55	55	55	56	56	56	56	57	57	57	57	57	58	58	58	58	59	59
-3.5	54	54	54	55	55	55	55	55	56	56	56	56	57	57	57	57	57	58	58	58
-3.0	53	54	54	54	54	54	55	55	55	55	55	56	56	56	56	57	57	57	57	58
-2.5	53	53	53	53	54	54	54	54	54	55	55	55	55	55	56	56	56	56	57	57
-2.0	52	52	53	53	53	53	53	54	54	54	54	54	55	55	55	55	55	56	56	56
-1.5	52	52	52	52	52	53	53	53	53	53	54	54	54	54	54	55	55	55	55	55
-1.0	51	51	52	52	52	52	52	52	53	53	53	53	53	53	54	54	54	54	54	55
-0.5	51	51	51	51	51	51	52	52	52	52	52	52	53	53	53	53	53	54	54	54

TABLE 19--Continued

Wet-bulb temperature (°C.)	Depression of the wet-bulb thermometer (dry-bulb minus wet-bulb)																			
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9
0.0	00	00	00	51	51	51	51	51	51	51	52	52	52	52	52	52	53	53	53	53
0.5	01	00	00	00	00	00	00	51	51	51	51	51	51	52	52	52	52	52	52	53
1.0	01	01	01	01	00	00	00	00	00	00	51	51	51	51	51	51	51	52	52	52
1.5	02	01	01	01	01	01	01	01	00	00	00	00	00	00	51	51	51	51	51	51
2.0	02	02	02	02	02	01	01	01	01	01	01	01	00	00	00	00	00	00	51	51
2.5	03	02	02	02	02	02	02	02	01	01	01	01	01	01	01	00	00	00	00	00
3.0	03	03	03	03	03	02	02	02	02	02	02	02	01	01	01	01	01	01	01	00
3.5	04	03	03	03	03	03	03	03	03	02	02	02	02	02	02	02	01	01	01	01
4.0	04	04	04	04	04	03	03	03	03	03	03	03	03	02	02	02	02	02	02	02
4.5	05	04	04	04	04	04	04	04	04	03	03	03	03	03	03	03	03	02	02	02
5.0	05	05	05	05	05	04	04	04	04	04	04	04	04	04	03	03	03	03	03	03
5.5	06	05	05	05	05	05	05	05	05	05	04	04	04	04	04	04	04	04	03	03
6.0	06	06	06	06	06	06	05	05	05	05	05	05	05	05	05	04	04	04	04	04
6.5	07	06	06	06	06	06	06	06	06	06	06	05	05	05	05	05	05	05	05	05
7.0	07	07	07	07	07	07	06	06	06	06	06	06	06	06	06	06	05	05	05	05
7.5	08	07	07	07	07	07	07	07	07	07	07	06	06	06	06	06	06	06	06	06
8.0	08	08	08	08	08	08	07	07	07	07	07	07	07	07	07	07	07	06	06	06
8.5	09	08	08	08	08	08	08	08	08	08	08	08	07	07	07	07	07	07	07	07
9.0	09	09	09	09	09	09	09	08	08	08	08	08	08	08	08	08	08	08	07	07
9.5	10	09	09	09	09	09	09	09	09	09	09	09	09	08	08	08	08	08	08	08
10.0	10	10	10	10	10	10	10	09	09	09	09	09	09	09	09	09	09	09	09	08
10.5	11	10	10	10	10	10	10	10	10	10	10	10	10	09	09	09	09	09	09	09
11.0	11	11	11	11	11	11	11	10	10	10	10	10	10	10	10	10	10	10	10	10
11.5	12	11	11	11	11	11	11	11	11	11	11	11	11	11	10	10	10	10	10	10
12.0	12	12	12	12	12	12	12	12	11	11	11	11	11	11	11	11	11	11	11	11
12.5	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11	11	11	11	11
13.0	13	13	13	13	13	13	13	13	12	12	12	12	12	12	12	12	12	12	12	12
13.5	14	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	12	12	12	12
14.0	14	14	14	14	14	14	14	14	14	13	13	13	13	13	13	13	13	13	13	13
14.5	15	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	13	13	13
15.0	15	15	15	15	15	15	15	15	15	14	14	14	14	14	14	14	14	14	14	14
15.5	16	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	14	14	14
16.0	16	16	16	16	16	16	16	16	16	16	15	15	15	15	15	15	15	15	15	15
16.5	17	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	15	15
17.0	17	17	17	17	17	17	17	17	17	17	16	16	16	16	16	16	16	16	16	16
17.5	18	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	16
18.0	18	18	18	18	18	18	18	18	18	18	18	17	17	17	17	17	17	17	17	17
18.5	19	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
19.0	19	19	19	19	19	19	19	19	19	19	19	18	18	18	18	18	18	18	18	18
19.5	20	20	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19

TABLE 19--Continued

Wet-bulb temperature (°C.)	Depression of the wet-bulb thermometer (dry-bulb minus wet-bulb)																			
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9
20.0	20	20	20	20	20	20	20	20	20	20	20	20	19	19	19	19	19	19	19	19
20.5	21	21	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
21.0	21	21	21	21	21	21	21	21	21	21	21	21	21	20	20	20	20	20	20	20
21.5	22	22	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
22.0	22	22	22	22	22	22	22	22	22	22	22	22	22	21	21	21	21	21	21	21
22.5	23	23	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
23.0	23	23	23	23	23	23	23	23	23	23	23	23	23	23	22	22	22	22	22	22
23.5	24	24	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
24.0	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	23	23	23	23	23
24.5	25	25	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
25.0	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	24	24	24	24	24
25.6	26	26	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
26.0	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	25	25	25	25
26.5	27	27	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
27.0	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	26	26	26
27.5	28	28	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27
28.0	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	27	27
28.5	29	29	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
29.0	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	28
29.5	30	30	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
30.0	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
30.5	31	31	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
31.0	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
31.5	32	32	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
32.0	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
32.5	33	33	33	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
33.0	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
33.5	34	34	34	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
34.0	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
34.5	35	35	35	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
35.0	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35

TABLE 19--Continued

Wet-bulb temperature (°C.)	Depression of the wet-bulb thermometer (dry-bulb minus wet-bulb)																				
	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	6.2
-20.0																						
-19.5																						
-19.0																						
-18.5																						
-18.0																						
-17.5																						
-17.0	01																					
-16.5	94																					
-16.0	90	01																				
-15.5	87	94																				
-15.0	84	90	99																			
-14.5	82	86	92																			
-14.0	80	84	88	96																		
-13.5	79	82	85	91																		
-13.0	77	80	83	87	93																	
-12.5	76	78	80	84	88	97																
-12.0	74	76	79	81	85	90	01															
-11.5	73	75	77	79	82	86	92															
-11.0	72	74	75	77	80	83	87	94														
-10.5	71	72	74	76	78	80	84	88	96													
10.0	70	71	73	74	76	78	81	84	89	98												
-9.5	69	70	71	73	74	76	78	81	85	90	00											
-9.0	68	69	70	71	73	74	76	79	81	85	90	02										
-8.5	67	68	69	70	71	73	75	76	79	81	85	91										
-8.0	66	67	68	69	70	71	73	75	76	79	82	85	91									
-7.5	65	66	67	68	69	70	71	73	75	76	79	81	85	90								
-7.0	64	65	66	67	68	69	70	71	73	74	76	78	81	85	90	01						
-6.5	63	64	65	66	67	68	69	70	71	73	74	76	78	81	84	89	99					
-6.0	62	63	64	65	66	67	68	69	70	71	72	74	76	78	80	84	88	97				
-5.5	62	62	63	64	65	65	66	67	68	69	71	72	74	75	77	80	83	87	94			
-5.0	61	62	62	63	64	64	65	66	67	68	69	70	72	73	75	77	79	82	86	92		
-4.5	60	61	61	62	63	63	64	65	66	67	68	69	70	71	73	74	76	78	81	85	90	00
-4.0	59	60	60	61	62	62	63	64	65	66	66	67	68	70	71	72	74	76	78	80	83	88
-3.5	59	59	60	60	61	61	62	63	64	64	65	66	67	68	69	70	72	73	75	77	79	82
-3.0	58	58	59	59	60	61	61	62	62	63	64	65	66	67	68	69	70	71	72	74	76	78
-2.5	57	58	58	59	59	60	60	61	61	62	63	64	64	65	66	67	68	69	70	72	73	75
-2.0	56	57	57	58	58	59	59	60	60	61	62	62	63	64	65	66	66	67	68	70	71	72
-1.5	56	56	56	57	57	58	58	59	59	60	61	61	62	63	63	64	65	66	67	68	69	70
-1.0	55	55	56	56	57	57	58	58	59	59	60	60	61	62	62	63	64	64	65	66	67	68
-0.5	54	55	55	55	56	56	57	57	58	58	59	59	60	60	61	62	62	63	64	65	65	66

TABLE 19--Continued

Wet-bulb temperature (°C.)	Depression of the wet-bulb thermometer (dry-bulb minus wet-bulb)																					
	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	6.2
0.0	53	54	54	55	55	55	56	56	57	57	58	58	59	59	60	60	61	62	62	63	64	65
0.5	53	53	54	54	54	55	55	56	56	56	57	57	58	58	59	60	60	61	61	62	63	63
1.0	52	53	53	53	54	54	54	55	55	56	56	57	57	58	58	59	59	60	60	61	62	62
1.5	52	52	52	53	53	53	54	54	54	55	55	56	56	57	57	58	58	59	59	60	60	61
2.0	51	51	52	52	52	53	53	53	54	54	55	55	55	56	56	57	57	58	58	59	59	60
2.5	00	51	51	51	52	52	52	53	53	53	54	54	55	55	55	56	56	57	57	58	58	59
3.0	00	00	00	51	51	51	52	52	52	53	53	53	54	54	55	55	55	56	56	57	57	58
3.5	01	01	00	00	00	51	51	51	52	52	52	53	53	53	54	54	55	55	55	56	56	57
4.0	02	01	01	01	00	00	00	51	51	51	52	52	52	53	53	53	54	54	55	55	55	56
4.5	02	02	02	01	01	01	00	00	00	51	51	51	52	52	52	53	53	53	54	54	55	55
5.0	03	02	02	02	02	01	01	01	00	00	00	51	51	51	51	52	52	53	53	53	54	54
5.5	03	03	03	02	02	02	02	01	01	01	01	00	00	00	51	51	51	52	52	52	53	53
6.0	04	04	03	03	03	03	02	02	02	02	01	01	01	00	00	00	51	51	51	52	52	52
6.5	04	04	04	04	03	03	03	03	02	02	02	02	01	01	01	01	00	00	51	51	51	51
7.0	05	05	05	04	04	04	04	03	03	03	03	02	02	02	01	01	01	01	00	00	00	51
7.5	06	05	05	05	05	04	04	04	04	03	03	03	03	02	02	02	02	01	01	01	01	00
8.0	06	06	06	05	05	05	05	05	04	04	04	04	03	03	03	03	02	02	02	02	01	01
8.5	07	06	06	06	06	06	05	05	05	05	05	04	04	04	04	03	03	03	03	02	02	02
9.0	07	07	07	07	06	06	06	06	06	05	05	05	05	04	04	04	04	04	03	03	03	03
9.5	08	08	07	07	07	07	07	06	06	06	06	06	05	05	05	05	04	04	04	04	03	03
10.0	08	08	08	08	08	07	07	07	07	07	06	06	06	06	06	05	05	05	05	04	04	04
10.5	09	09	09	08	08	08	08	08	07	07	07	07	07	06	06	06	06	06	05	05	05	05
11.0	09	09	09	09	09	09	08	08	08	08	08	07	07	07	07	07	06	06	06	06	06	05
11.5	10	10	10	09	09	09	09	09	09	08	08	08	08	08	07	07	07	07	07	06	06	06
12.0	11	10	10	10	10	10	10	09	09	09	09	09	08	08	08	08	08	08	07	07	07	07
12.5	11	11	11	11	10	10	10	10	10	10	09	09	09	09	09	09	08	08	08	08	08	07
13.0	12	11	11	11	11	11	11	11	10	10	10	10	10	10	09	09	09	09	09	08	08	08
13.5	12	12	12	12	12	11	11	11	11	11	11	10	10	10	10	10	10	09	09	09	09	09
14.0	13	13	12	12	12	12	12	12	12	11	11	11	11	11	11	10	10	10	10	10	10	09
14.5	13	13	13	13	13	13	12	12	12	12	12	12	12	11	11	11	11	11	11	10	10	10
15.0	14	14	14	13	13	13	13	13	13	13	12	12	12	12	12	12	12	11	11	11	11	11
15.5	14	14	14	14	14	14	14	13	13	13	13	13	13	13	12	12	12	12	12	12	12	11
16.0	15	15	15	14	14	14	14	14	14	14	14	13	13	13	13	13	13	13	12	12	12	12
16.5	15	15	15	15	15	15	15	15	14	14	14	14	14	14	14	13	13	13	13	13	13	13
17.0	16	16	16	16	15	15	15	15	15	15	15	15	14	14	14	14	14	14	14	14	13	13
17.5	16	16	16	16	16	16	16	16	15	15	15	15	15	15	15	15	15	14	14	14	14	14
18.0	17	17	17	17	17	16	16	16	16	16	16	16	16	15	15	15	15	15	15	15	15	14
18.5	18	17	17	17	17	17	17	17	17	17	16	16	16	16	16	16	16	16	15	15	15	15
19.0	18	18	18	18	18	17	17	17	17	17	17	17	17	17	16	16	16	16	16	16	16	16
19.5	19	18	18	18	18	18	18	18	18	18	18	17	17	17	17	17	17	17	17	17	16	16

TABLE 19--Continued

Wet-bulb temperature (°C.)	Depression of the wet-bulb thermometer (dry-bulb minus wet-bulb)																				
	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	6.2
20.0	19	19	19	19	19	19	18	18	18	18	18	18	18	18	18	18	17	17	17	17	17	17
20.5	20	20	19	19	19	19	19	19	19	19	19	19	18	18	18	18	18	18	18	18	18	17
21.0	20	20	20	20	20	20	20	19	19	19	19	19	19	19	19	19	19	18	18	18	18	18
21.5	21	21	20	20	20	20	20	20	20	20	20	20	20	19	19	19	19	19	19	19	19	19
22.0	21	21	21	21	21	21	21	21	20	20	20	20	20	20	20	20	20	20	20	19	19	19
22.5	22	22	22	21	21	21	21	21	21	21	21	21	21	21	20	20	20	20	20	20	20	20
23.0	22	22	22	22	22	22	22	22	22	21	21	21	21	21	21	21	21	21	21	21	20	20
23.5	23	23	23	23	22	22	22	22	22	22	22	22	22	22	22	21	21	21	21	21	21	21
24.0	23	23	23	23	23	23	23	23	23	23	22	22	22	22	22	22	22	22	22	22	22	22
24.5	24	24	24	24	23	23	23	23	23	23	23	23	23	23	23	23	23	22	22	22	22	22
25.0	24	24	24	24	24	24	24	24	24	24	24	23	23	23	23	23	23	23	23	23	23	23
25.5	25	25	25	25	25	24	24	24	24	24	24	24	24	24	24	24	24	24	23	23	23	23
26.0	25	25	25	25	25	25	25	25	25	25	25	25	24	24	24	24	24	24	24	24	24	24
26.5	26	26	26	26	26	26	25	25	25	25	25	25	25	25	25	25	25	25	25	24	24	24
27.0	26	26	26	26	26	26	26	26	26	26	26	26	26	25	25	25	25	25	25	25	25	25
27.5	27	27	27	27	27	27	27	26	26	26	26	26	26	26	26	26	26	26	26	26	26	25
28.0	27	27	27	27	27	27	27	27	27	27	27	27	27	27	26	26	26	26	26	26	26	26
28.5	28	28	28	28	28	28	28	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27
29.0	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	27	27	27	27	27	27
29.5	29	29	29	29	29	29	29	29	28	28	28	28	28	28	28	28	28	28	28	28	28	28
30.0	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	28	28	28	28	28
30.5	30	30	30	30	30	30	30	30	30	29	29	29	29	29	29	29	29	29	29	29	29	29
31.0	31	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	29	29	29	29
31.5	31	31	31	31	31	31	31	31	31	31	30	30	30	30	30	30	30	30	30	30	30	30
32.0	32	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	30	30
32.5	32	32	32	32	32	32	32	32	32	32	32	31	31	31	31	31	31	31	31	31	31	31
33.0	33	33	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	31
33.5	33	33	33	33	33	33	33	33	33	33	33	33	32	32	32	32	32	32	32	32	32	32
34.0	34	34	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
34.5	34	34	34	34	34	34	34	34	34	34	34	34	34	33	33	33	33	33	33	33	33	33
35.0	35	35	35	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34

TABLE 19--Continued

Wet-bulb temperature (°C.)	Depression of the wet-bulb thermometer (dry bulb minus wet-bulb)																			
	6.4	6.6	6.8	7.0	7.2	7.4	7.6	7.8	8.0	8.2	8.4	8.6	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.2	10.4
-5.0																					
-4.5																					
-4.0	95																				
-3.5	86	92																			
-3.0	80	84	88	97																	
-2.5	77	79	82	86	92																
-2.0	74	76	78	80	83	88	96														
-1.5	71	73	74	76	79	81	85	90	02												
-1.0	69	70	72	73	75	77	79	82	86	93											
-0.5	67	68	70	71	72	74	75	77	80	81	88	95									
0.0	66	67	67	69	70	71	72	74	76	78	80	84	88	97							
0.5	64	65	66	67	68	69	70	71	73	75	76	79	81	85	91						
1.0	63	64	64	65	66	67	68	69	70	72	73	75	77	79	82	86	93				
1.5	62	62	63	64	65	65	66	67	68	69	71	72	74	75	78	80	83	88	95		
2.0	60	61	62	62	63	64	65	66	67	67	69	70	71	72	74	76	78	80	84	89	97
2.5	59	60	61	61	62	63	63	64	65	66	67	68	69	70	71	73	74	76	78	81	84
3.0	58	59	59	60	61	61	62	63	63	64	65	66	67	68	69	70	71	73	74	76	78
3.5	57	58	58	59	59	60	61	61	62	63	63	64	65	66	67	68	69	70	71	73	74
4.0	56	57	57	58	58	59	59	60	61	61	62	62	63	64	65	66	67	68	69	70	71
4.5	55	56	56	57	57	58	58	59	59	60	60	61	62	62	63	64	65	66	66	67	68
5.0	54	55	55	56	56	57	57	58	58	59	59	60	60	61	62	62	63	64	65	65	66
5.5	54	54	54	55	55	56	56	56	57	57	58	58	59	60	60	61	61	62	63	63	64
6.0	53	53	53	54	54	55	55	55	56	56	57	57	58	58	59	59	60	61	61	62	63
6.5	52	52	53	53	53	54	54	54	55	55	56	56	57	57	58	58	59	59	60	60	61
7.0	51	51	52	52	52	53	53	53	54	54	55	55	55	56	56	57	57	58	58	59	59
7.5	00	00	51	51	51	52	52	52	53	53	54	54	54	55	55	56	56	57	57	58	58
8.0	01	00	00	00	51	51	51	52	52	52	53	53	53	54	54	55	55	55	56	56	57
8.5	01	01	01	01	00	00	00	51	51	51	52	52	52	53	53	53	54	54	55	55	55
9.0	02	02	02	01	01	01	01	00	00	00	51	51	51	52	52	52	53	53	54	54	54
9.5	03	03	02	02	02	02	01	01	01	01	00	00	00	51	51	51	52	52	52	53	53
10.0	04	03	03	03	03	02	02	02	02	01	01	01	01	00	00	00	51	51	51	52	52
10.5	04	04	04	04	04	03	03	03	03	02	02	02	01	01	01	01	00	00	00	51	51
11.0	05	05	05	04	04	04	04	04	03	03	03	03	02	02	02	01	01	01	01	00	00
11.5	06	06	05	05	05	05	05	04	04	04	04	03	03	03	03	02	02	02	02	01	01
12.0	07	06	06	06	06	06	05	05	05	05	04	04	04	04	03	03	03	03	02	02	02
12.5	07	07	07	07	06	06	06	06	06	05	05	05	05	05	04	04	04	04	03	03	03
13.0	08	08	08	07	07	07	07	07	06	06	06	06	06	05	05	05	05	04	04	04	04
13.5	09	08	08	08	08	08	07	07	07	07	07	06	06	06	06	06	05	05	05	05	05
14.0	09	09	09	09	09	08	08	08	08	08	07	07	07	07	07	06	06	06	06	06	05
14.5	10	10	10	09	09	09	09	09	09	08	08	08	08	08	07	07	07	07	07	06	06

TABLE 19--Continued

Wet-bulb temperature (°C.)	Depression of the wet-bulb thermometer (dry-bulb minus wet-bulb																				
	6.4	6.6	6.8	7.0	7.2	7.4	7.6	7.8	8.0	8.2	8.4	8.6	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.2	10.4
15.0	11	10	10	10	10	10	10	09	09	09	09	09	09	08	08	08	08	08	07	07	07
15.5	11	11	11	11	11	10	10	10	10	10	10	09	09	09	09	09	09	08	08	08	08
16.0	12	12	12	11	11	11	11	11	11	10	10	10	10	10	10	09	09	09	09	09	09
16.5	12	12	12	12	12	12	12	11	11	11	11	11	11	11	10	10	10	10	10	10	09
17.0	13	13	13	13	13	12	12	12	12	12	12	12	11	11	11	11	11	11	10	10	10
17.5	14	14	13	13	13	13	13	13	13	12	12	12	12	12	12	12	11	11	11	11	11
18.0	14	14	14	14	14	14	14	13	13	13	13	13	13	13	12	12	12	12	12	12	12
18.5	15	15	15	15	14	14	14	14	14	14	14	14	13	13	13	13	13	13	13	12	12
19.0	16	15	15	15	15	15	15	15	15	14	14	14	14	14	14	14	14	13	13	13	13
19.5	16	16	16	16	16	16	15	15	15	15	15	15	15	15	14	14	14	14	14	14	14
20.0	17	17	17	16	16	16	16	16	16	16	16	15	15	15	15	15	15	15	15	14	14
20.5	17	17	17	17	17	17	17	17	16	16	16	16	16	16	16	16	16	15	15	15	15
21.0	18	18	18	18	18	17	17	17	17	17	17	17	17	17	16	16	16	16	16	16	16
21.5	19	18	18	18	18	18	18	18	18	18	17	17	17	17	17	17	17	17	17	16	16
22.0	19	19	19	19	19	19	19	18	18	18	18	18	18	18	18	18	17	17	17	17	17
22.5	20	20	20	19	19	19	19	19	19	19	19	19	19	18	18	18	18	18	18	18	18
23.0	20	20	20	20	20	20	20	20	20	19	19	19	19	19	19	19	19	19	19	18	18
23.5	21	21	21	21	20	20	20	20	20	20	20	20	20	20	20	19	19	19	19	19	19
24.0	21	21	21	21	21	21	21	21	21	21	21	20	20	20	20	20	20	20	20	20	20
24.5	22	22	22	22	22	22	21	21	21	21	21	21	21	21	21	21	21	21	20	20	20
25.0	23	22	22	22	22	22	22	22	22	22	22	22	22	21	21	21	21	21	21	21	21
25.5	23	23	23	23	23	23	23	23	22	22	22	22	22	22	22	22	22	22	22	22	21
26.0	24	24	24	23	23	23	23	23	23	23	23	23	23	23	23	23	22	22	22	22	22
26.5	24	24	24	24	24	24	24	24	24	24	23	23	23	23	23	23	23	23	23	23	23
27.0	25	25	25	25	25	24	24	24	24	24	24	24	24	24	24	24	24	24	23	23	23
27.5	25	25	25	25	25	25	25	25	25	25	25	25	25	24	24	24	24	24	24	24	24
28.0	26	26	26	26	26	26	26	25	25	25	25	25	25	25	25	25	25	25	25	25	25
28.5	27	26	26	26	26	26	26	26	26	26	26	26	26	26	26	25	25	25	25	25	25
29.0	27	27	27	27	27	27	27	27	27	26	26	26	26	26	26	26	26	26	26	26	26
29.5	28	28	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	26	26	26	26
30.0	28	28	28	28	28	28	28	28	28	28	28	27	27	27	27	27	27	27	27	27	27
30.5	29	29	29	29	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	27
31.0	29	29	29	29	29	29	29	29	29	29	29	29	29	28	28	28	28	28	28	28	28
31.5	30	30	30	30	30	30	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
32.0	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	29	29	29	29	29	29
32.5	31	31	31	31	31	31	31	30	30	30	30	30	30	30	30	30	30	30	30	30	30
33.0	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	30	30	30
33.5	32	32	32	32	32	32	32	32	32	31	31	31	31	31	31	31	31	31	31	31	31
34.0	33	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	31
34.5	33	33	33	33	33	33	33	33	33	33	33	32	32	32	32	32	32	32	32	32	32
35.0	34	34	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33

TABLE 19--Continued

Wet-bulb temperature (°C.)	Depression of the wet-bulb thermometer (dry-bulb minus wet-bulb)																					
	10.6	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.2	12.4	12.6	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.4	14.6	14.8
10.0	52	53	53	54	54	54	55	55	56	56	57	57	57	58	59	59	60	60	61	62	62	63
10.5	51	52	52	52	53	53	54	54	54	55	55	56	56	56	57	57	58	58	59	60	60	61
11.0	00	51	51	51	52	52	52	53	53	53	54	54	55	55	56	56	56	57	57	58	58	59
11.5	01	00	00	00	51	51	51	52	52	52	53	53	53	54	54	55	55	55	56	56	57	57
12.0	02	01	01	01	00	00	00	51	51	51	51	52	52	53	53	53	54	54	54	55	55	56
12.5	03	02	02	02	01	01	01	01	00	00	00	51	51	51	52	52	52	53	53	53	54	54
13.0	03	03	03	03	02	02	02	02	01	01	01	00	00	00	51	51	51	52	52	52	53	53
13.5	04	04	04	04	03	03	03	03	02	02	02	02	01	01	01	00	00	00	51	51	51	52
14.0	05	05	05	04	04	04	04	04	03	03	03	03	02	02	02	01	01	01	01	00	00	00
14.5	06	06	06	05	05	05	05	04	04	04	04	04	03	03	03	02	02	02	02	01	01	01
15.0	07	07	06	06	06	06	06	05	05	05	05	04	04	04	04	03	03	03	03	02	02	02
15.5	08	07	07	07	07	07	06	06	06	06	06	05	05	05	05	04	04	04	04	04	03	03
16.0	08	08	08	08	08	07	07	07	07	07	06	06	06	06	06	05	05	05	05	05	04	04
16.5	09	09	09	09	08	08	08	08	08	08	07	07	07	07	07	06	06	06	06	05	05	05
17.0	10	10	10	09	09	09	09	09	09	08	08	08	08	08	07	07	07	07	07	06	06	06
17.5	11	11	10	10	10	10	10	10	09	09	09	09	09	08	08	08	08	08	08	07	07	07
18.0	11	11	11	11	11	11	10	10	10	10	10	10	09	09	09	09	09	09	08	08	08	08
18.5	12	12	12	12	12	11	11	11	11	11	11	10	10	10	10	10	10	09	09	09	09	09
19.0	13	13	13	12	12	12	12	12	12	12	11	11	11	11	11	11	10	10	10	10	10	10
19.5	14	13	13	13	13	13	13	13	12	12	12	12	12	12	12	11	11	11	11	11	11	10
20.0	14	14	14	14	14	14	13	13	13	13	13	13	13	12	12	12	12	12	12	12	11	11
20.5	15	15	15	15	14	14	14	14	14	14	14	13	13	13	13	13	13	13	12	12	12	12
21.0	16	15	15	15	15	15	15	15	15	14	14	14	14	14	14	14	14	13	13	13	13	13
21.5	16	16	16	16	16	16	16	15	15	15	15	15	15	15	15	14	14	14	14	14	14	14
22.0	17	17	17	17	16	16	16	16	16	16	16	16	16	15	15	15	15	15	15	15	15	14
22.5	18	17	17	17	17	17	17	17	17	17	16	16	16	16	16	16	16	16	16	15	15	15
23.0	18	18	18	18	18	18	18	17	17	17	17	17	17	17	17	17	16	16	16	16	16	16
23.5	19	19	19	19	18	18	18	18	18	18	18	18	18	17	17	17	17	17	17	17	17	17
24.0	19	19	19	19	19	19	19	19	19	19	18	18	18	18	18	18	18	18	18	18	17	17
24.5	20	20	20	20	20	20	20	19	19	19	19	19	19	19	19	19	19	18	18	18	18	18

TABLE 19--Continued

Wet-bulb temperature (°C.)	Depression of the wet-bulb thermometer (dry-bulb minus wet-bulb)																				
	10.6	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.2	12.4	12.6	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.4	14.6	14.8
25.0	21	21	21	20	20	20	20	20	20	20	20	20	20	20	19	19	19	19	19	19	19	19
25.5	21	21	21	21	21	21	21	21	21	21	20	20	20	20	20	20	20	20	20	20	20	19
26.0	22	22	22	22	22	22	21	21	21	21	21	21	21	21	21	21	21	20	20	20	20	20
26.5	23	23	22	22	22	22	22	22	22	22	22	22	22	22	21	21	21	21	21	21	21	21
27.0	23	23	23	23	23	23	23	23	23	22	22	22	22	22	22	22	22	22	22	22	22	21
27.5	24	24	24	24	24	23	23	23	23	23	23	23	23	23	23	23	23	22	22	22	22	22
28.0	24	24	24	24	24	24	24	24	24	24	24	24	24	23	23	23	23	23	23	23	23	23
28.5	25	25	25	25	25	25	25	25	24	24	24	24	24	24	24	24	24	24	24	24	24	23
29.0	26	26	25	25	25	25	25	25	25	25	25	25	25	25	25	25	24	24	24	24	24	24
29.5	26	26	26	26	26	26	26	26	26	26	26	25	25	25	25	25	25	25	25	25	25	25
30.0	27	27	27	27	27	26	26	26	26	26	26	26	26	26	26	26	26	26	26	25	25	25
30.5	27	27	27	27	27	27	27	27	27	27	27	27	27	27	26	26	26	26	26	26	26	26
31.0	28	28	28	28	28	28	28	28	27	27	27	27	27	27	27	27	27	27	27	27	27	27
31.5	29	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	27	27	27	27	27
32.0	29	29	29	29	29	29	29	29	29	29	29	28	28	28	28	28	28	28	28	28	28	28
32.5	30	30	30	30	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	28
33.0	30	30	30	30	30	30	30	30	30	30	30	30	30	30	29	29	29	29	29	29	29	29
33.5	31	31	31	31	31	31	31	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
34.0	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	30	30	30	30	30
34.5	32	32	32	32	32	32	32	32	32	32	31	31	31	31	31	31	31	31	31	31	31	31
35.0	33	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	31

*Note: Negative dewpoints are encoded in this table. All dewpoint values of 50 or higher represent coded negative values. These values may be decoded by subtracting 50 from the listed value and placing a minus sign ahead of the result. E.g., Table value "66" = -16°C.

TABLE 20

I_S **Symbol I_s.—Ice Accretion on Ship**

Code Figures	Description
1	Icing from ocean spray.
2	Icing from fog.
3	Icing from spray and fog.
4	Icing from rain.
5	Icing from spray and rain.

TABLE 21

E_SE_S THICKNESS OF ICE ACCRETION ON SHIPS IN CENTIMETERS

Code Figure	Thickness
00	Less than 1 cm. or 0.4 in.
01	1 cm. or 0.4 in.
02	2 cm. or 0.8 in.
03	3 cm. or 1.2 in.
04	4 cm. or 1.6 in.
05	5 cm. or 2.0 in.
06	6 cm. or 2.4 in.
07	7 cm. or 2.8 in.
08	8 cm. or 3.2 in.
09	9 cm. or 3.6 in.
10	10 cm. or 4.0 in.
etc.	

TABLE 22

R_S **Symbol R_s.—Rate of Ice Accretion on Ships**

Code Figures	Description
0	Ice not building up.
1	Ice building up slowly.
2	Ice building up rapidly.
3	Ice melting or breaking up slowly.
4	Ice melting or breaking up rapidly.

TABLE 23

P_WP_W PERIOD OF WIND WAVES IN SECONDS

Report the average period in seconds of the wind waves using two figures. 5 sec. = 05, 10 sec. = 10, etc.

TABLE 24

H_WH_W HEIGHT OF WIND WAVES AND SWELL

Use "00" for calm. Use two slants "//" when the height was not observed for any reason.

Half-Meters Code Figure	Feet	Half-Meters Code Figure	Feet	Half-Meters Code Figure	Feet	Half-Meters Code Figure	Feet
00	2	21	34	41	67	61	100
02	3	22	36	42	69	62	102
03	5	23	38	43	71	63	103
04	7	24	39	44	72	64	105
05	8	25	41	45	74	65	107
06	10	26	43	46	76	66	108
07	12	27	44	47	77	67	110
08	13	28	46	48	79	68	112
09	15	29	48	49	80	69	113
10	16	30	49	50	82	70	115
11	18	31	51	51	84	71	117
12	20	32	52	52	85	72	118
13	21	33	54	53	87	73	120
14	23	34	56	54	89	74	121
15	25	35	57	55	90	75	123
16	26	36	59	56	92	76	125
17	28	37	61	57	94	77	126
18	30	38	62	58	95	78	128
19	31	39	64	59	97	79	130
20	33	40	66	60	98	80	131

TABLE 25

$d_W d_W$ SWELL DIRECTION, TENS OF DEGREES

(From which the swell is coming)

Code Figure	Direction	Code Figure	Direction
00	Calm	19	185° to 194°
01	5° to 14°	20	195° to 204°
02	15° to 24°	21	205° to 214°
03	25° to 34°	22	215° to 224°
04	35° to 44°	23	225° to 234°
05	45° to 54°	24	235° to 244°
06	55° to 64°	25	245° to 254°
07	65° to 74°	26	255° to 264°
08	75° to 84°	27	265° to 274°
09	85° to 94°	28	275° to 284°
10	95° to 104°	29	285° to 294°
11	105° to 114°	30	295° to 304°
12	115° to 124°	31	305° to 314°
13	125° to 134°	32	315° to 324°
14	135° to 144°	33	325° to 334°
15	145° to 154°	34	335° to 344°
16	155° to 164°	35	345° to 354°
17	165° to 174°	36	355° to 4°
18	175° to 184°	99	Direction cannot be determined due to a confused sea

Note: If the swell direction is not confused and a direction cannot otherwise be determined, omit the entire swell group ($d_W d_W P_W H_W H_W$).

TABLE 26

P_W PERIOD OF SWELL

Code Figure	Average Period in Sec.	Code Figure	Average Period in Sec.
5	5 or less	0	10
6	6	1	11
7	7	2	12
8	8	4	14 or more
9	9	/	Calm or not determined

TABLE 27	
c_2	SYMBOL c_2. --Description of kind of ice.
Code figure	Description
0	No ice. ("0" will be used to report "Ice blink," and then a direction must be reported.)
1	New ice.
2	Fast ice.
3	Pack ice
4	Packed (compact) slush
5	Shore lead.
6	Heavy fast ice.
7	Heavy pack ice.
8	Hummocked ice.
9	Icebergs.

TABLE 28	
K	SYMBOL K. --Effect of ice on navigation
Code figure	Description
0	Navigation unobstructed.
1	Navigation unobstructed for steamers; difficult for sailing ships.
2	Navigation difficult for low-powered steamers; closed to sailing ships.
3	Navigation possible only for powerful steamers.
4	Navigation possible only for steamers constructed to withstand ice pressure.
5	Navigation possible with the assistance of icebreakers.
6	Channel open in the solid ice.
7	Navigation temporarily closed.
8	Navigation closed.
9	Navigation conditions unknown (e.g., owing to bad weather).

TABLE 29

D_i SYMBOL D_i.—*Bearing of ice-limit*

Code figure	Description
0	No ice limit can be stated.
1	Ice-limit toward NE.
2	Ice-limit toward E.
3	Ice-limit toward SE.
4	Ice-limit toward S.
5	Ice-limit toward SW.
6	Ice-limit toward W.
7	Ice-limit toward NW.
8	Ice-limit toward N.
9	Ice-limit in several directions.

NOTE.—If more than one ice-limit can be stated, the nearest or most important is reported.

TABLE 30

r SYMBOL r.—*Distance to ice-limit from reporting ship*

Code figure	Distance
0	0 to 1 mile.
1	1 to 2 miles.
2	2 to 4 miles.
3	4 to 6 miles.
4	6 to 8 miles.
5	8 to 12 miles.
6	12 to 16 miles.
7	16 to 20 miles.
8	More than 20 miles.
9	Unspecified or no observations.

NOTE.—If the exact bounding distance for the ice-limit corresponds to two code figures, the lower code figure is reported.

TABLE 31	
e	Orientation of ice-limit
Code figure	Orientation of ice-limit
0	Orientation of ice-limit impossible to estimate--ship outside the ice.
1	Ice-edge lying in a direction NE. to SW. with ice situated to the NW.
2	Ice-edge lying in a direction E. to W. with ice situated to the northward.
3	Ice-edge lying in a direction SE. to NW. with ice situated to the NE.
4	Ice-edge lying in a direction S. to N. with ice situated to the eastward.
5	Ice-edge lying in a direction SW. to NE. with ice situated to the SE.
6	Ice-edge lying in a direction W. to E. with ice situated to the southward.
7	Ice-edge lying in a direction NW. to SE. with ice situated to the SW.
8	Ice-edge lying in a direction N. to S. with ice situated to the westward.
9	Orientation of ice-limit impossible to estimate--ship inside the ice.

Figure	